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ABSTRACT

The National Science Foundation's (NSF) Directorate for Education and Human Resources (EHR) is responsible for providing national leadership and support for improving the quality of science, mathematics, engineering, and technology (SME&T) education from kindergarten through graduate school. The ultimate goal is to achieve excellence in the preparation of future U.S. teachers who are knowledgeable in their content areas and in the practice of teaching, creative and enthusiastic, and dedicated to life-long learning. This publication provides project descriptions for Teacher Preparation Awards and NSF Collaboratives for Excellence in Teacher Preparation Awards. The projects described received either new, continuation, or supplemental awards in Fiscal Year 1996. Projects funded through the Collaboratives program and projects funded through other programs managed by the Division of Undergraduate Education (DUE) are included. These projects provide models of exciting programs in teacher education that have the potential for significant national impact. The content and pedagogy serve a diverse set of students and institutions, and respond to the call for new directions. (JRH)

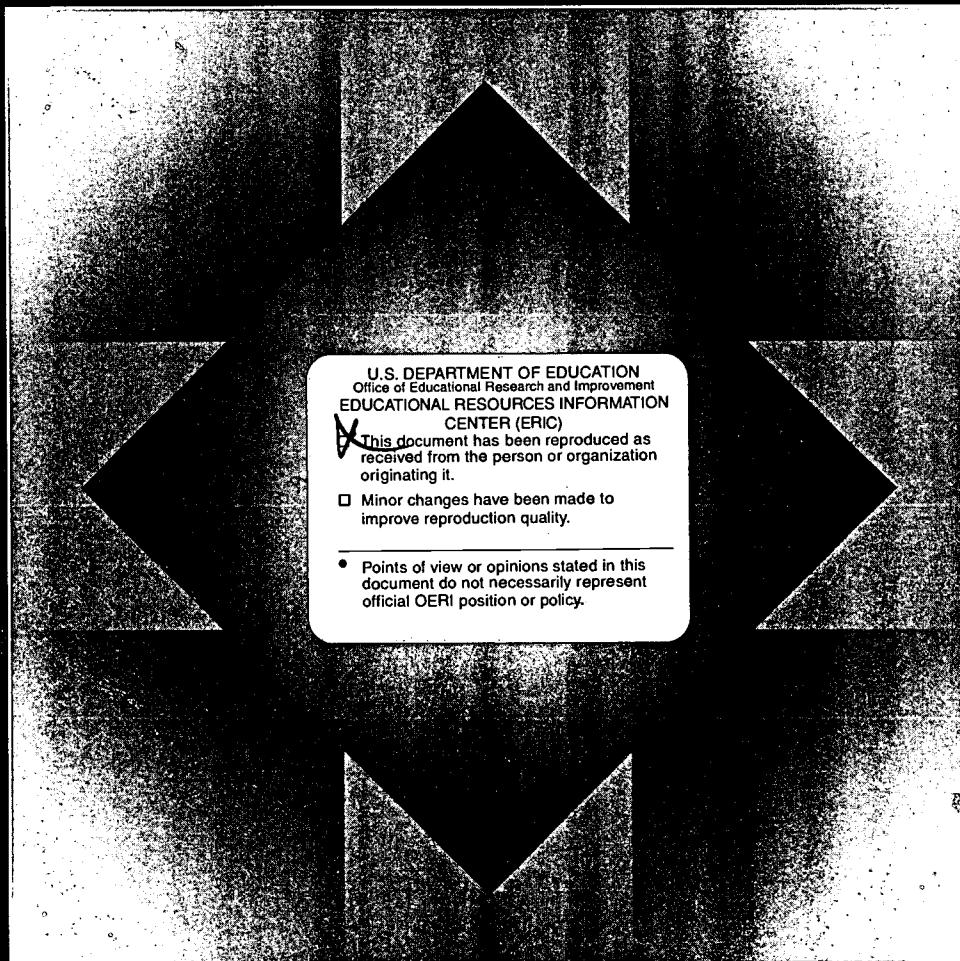
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FY 96 AWARDS

ED 407 247

TEACHER PREPARATION AND NSF COLLABORATIVES FOR EXCELLENCE IN TEACHER PREPARATION



Directorate for Education and Human Resources
Division of Undergraduate Education



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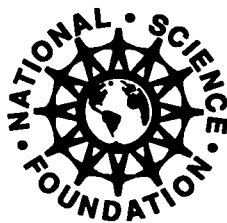
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DIVISION OF UNDERGRADUATE EDUCATION (DUE)
TEACHER PREPARATION AWARDS
NSF COLLABORATIVES FOR EXCELLENCE IN TEACHER PREPARATION
AWARDS

FISCAL YEAR 1996

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Foreword

The National Science Foundation (NSF)'s Directorate for Education and Human Resources (EHR) is responsible for providing national leadership and support for improving the quality of science, mathematics, engineering, and technology (SME&T) education, kindergarten through graduate school. In exercising this responsibility, the Directorate has established the SME&T education of future K-12 teachers as its highest priority. The ultimate goal is to achieve excellence in the preparation of the nation's future teachers – teachers who are knowledgeable in their content areas and in the practice of teaching, creative and enthusiastic, and dedicated to life-long learning.

Teacher preparation is a complex undertaking. In fact, every component of the nation's educational enterprise must be engaged to achieve success in this critical endeavor, including, for example: undergraduate institutions and, in particular, their mathematics, science, and education faculties and departments; practicing K-12 teachers; schools and school districts and their administrators; organizations responsible for teacher certification and licensure; developers of national standards in the sciences and mathematics; providers of informal educational experiences (science centers, museums, zoos); and parent, community and business organizations. The entire educational enterprise will benefit, both directly and indirectly, through a focus on improving this educational workforce.

The NSF effort in teacher preparation bridges several divisions of EHR. Primary programmatic emphasis and responsibility for coordination resides in the Division of Undergraduate Education (DUE), reflecting the fundamental role of undergraduate education in the preparation of teachers. The NSF Collaboratives for Excellence in Teacher Preparation (CETP) program, with additional support within other programs of the Division, is central to EHR's efforts to effect long-lasting institutional reform in teacher preparation. The Collaboratives are developing the state and regional approaches necessary for systemic change, engaging a broad range of stakeholders in the design of exemplary courses and programs.

The projects described in this book received either new, continuation, or supplemental awards in Fiscal Year 1996. Included are projects funded through the Collaboratives program and projects funded through other programs managed by DUE. These projects provide models of exciting programs in teacher education; all of them have the potential for significant national impact. They are rich in content, current in pedagogy, serve a diverse set of students and institutions, and respond to the call for new directions. The projects set high standards for future efforts in SME&T teacher preparation. We are proud of these projects and commend the individuals who have designed and are implementing them.

Luther S. Williams
Assistant Director
Education and Human Resources

**NATIONAL SCIENCE FOUNDATION
Directorate for Education and Human Resources
Division of Undergraduate Education**

**Teacher Preparation Awards
NSF Collaboratives for Excellence in Teacher Preparation Awards**

INTRODUCTION

Overview

The National Science Foundation (NSF) is undertaking a major effort to improve significantly the mathematics, technology, and science education of prospective elementary and secondary teachers. A basic premise of the Foundation's efforts in this regard is that the mathematics, technology, and science that prospective teachers learn as part of their undergraduate education, and the manner in which the courses are presented, have a critical influence on the quality of their teaching. Knowledgeable teachers who are excited about the subjects they teach will ensure that their students in K-12 are well prepared in science and mathematics and are technologically literate. Because of the great importance of this undergraduate experience, the design and implementation of teacher preparation programs require leadership from faculty in all science, mathematics, engineering, and technology (SME&T) disciplines working in partnership with their colleagues in education and teachers in the K-12 community, each providing their special expertise.

The Division of Undergraduate Education (DUE) manages two major programmatic efforts in teacher preparation:

1. The **NSF Collaboratives for Excellence in Teacher Preparation (CETP)** program, which supports large scale systemic projects designed to significantly change teacher preparation programs on a state or regional basis and to serve as comprehensive national models.
2. Support of projects concentrating on one course or a series of related courses through proposals submitted to the various DUE programs. These include the **Advanced Technological Education (ATE)** program, the **Course and Curriculum Development (CCD)** program, the **Instrumentation and Laboratory Improvement (ILI)** program, and the **Undergraduate Faculty Enhancement (UFE)** program.

In addition to these programs, NSF also promotes national leadership through activities such as conferences and workshops. For example, in FY 96 two important conferences focusing on issues in teacher preparation were funded by DUE: **Seizing Opportunities: Collaborating for Excellence in Teacher Preparation**, an invitational forum on teacher preparation for deans of science and education, jointly sponsored with the American Association for the Advancement of Science; and **Symposium on Improving Teacher Preparation and Certification Consistent with the National Science Education Standards**, jointly sponsored with the Council of Chief State School Officers.

Summary of Awards

NSF Collaboratives for Excellence in Teacher Preparation

Collaborative projects typically involve cooperative efforts that include science, mathematics, and education faculty and their departments working in consort with school personnel and appropriate institutional administrators. Since attention to introductory science and mathematics courses is essential, the Collaboratives feature strong leadership by the faculty and departments responsible for these courses. Each year the program expects to fund three to five projects to a level of \$500,000 to \$1,000,000 per year for up to five years.

New Projects: Each of the three collaboratives newly funded in FY 96 serve a broad region of their state and include a diverse set of two-year, four-year, and comprehensive institutions. A total of 20 institutions of higher education are involved. The San Francisco Bay Collaborative serves a large urban area. Participating institutions include: City College of San Francisco, the College of San Mateo, Evergreen Valley College, San Francisco State University, San Jose City College, and San Jose State University. The Oklahoma Teacher Education Collaborative includes a broad set of institutions within the state: Cameron University, Langston University, Northeastern State University, Oklahoma State University, Southwestern Oklahoma State University, the University of Central Oklahoma, the University of Oklahoma, and the University of Tulsa. The Virginia Urban Corridor Teacher Preparation Collaborative also involves a broad urban area and includes: Longwood College, Mary Washington College, Norfolk State College, J. Sargeant Reynolds, Tidewater and Germana Community Colleges, Virginia Commonwealth University and the Central Virginia Mathematics and Science Center.

These projects feature participation of groups and settings not previously intimately involved with teacher preparation in SME&T. Student groups targeted include such unique populations as those preparing to be teachers aides (para-teachers). Key participants in the projects' efforts to incorporate creative methods of teaching in SME&T course reform include master K-12 teachers, actively involved as equal partners both in course and program development and in faculty enhancement. Institutions involved in project activities include such informal, but rich settings as museums, research laboratories, and zoological parks. Activities include: summer academies to engage all stakeholders, including students, in course design, implementation, and assessment; integrated capstone courses designed by faculty from multiple disciplines; and systems to identify and support a cohort of students preparing to be teachers from their freshman experience through their first three years of teaching.

Continuing Projects: The 10 Collaboratives first funded in FY 93 through FY 95 continued to be supported in FY 96. More than 110 institutions are involved. The projects represent a rich diversity of approaches to comprehensive change in teacher preparation, offering different models for educational reform in mathematics and the sciences. Each project differs from the others in its needs, resources, participating institutional types, population, geography, and cultural and political traditions. Six of the projects – those from Arizona State University, California State University at Dominguez Hills, the City University of New York, Harvard University, Temple University, and the University of Texas at El Paso – are urban centered; three projects – in Louisiana, Maryland and Montana – encompass institutions distributed throughout the state; and one – from northern Colorado – is regional in character. All include strong leadership and participation from faculty in mathematics and science departments working collaboratively with faculty from departments of education.

The projects represent a variety of approaches. The Arizona Collaborative is designing an interdisciplinary course examining the nature of matter. The Los Angeles Collaborative is organizing its students in cohort groups and is creating strong ties across two year and four year institutions within the Los Angeles Basin. The El Paso Collaborative is closely integrating its activities with those of other systemic initiatives in its region. The City University of New York is designing materials for its courses which reflect the urban setting of the institutions involved. The project in Boston/Cambridge is developing new interdisciplinary courses over a range of campuses and is establishing strong ties with professional development schools. Participants in the Colorado project are cooperating to integrate courses in pedagogy with mathematics and science courses. The cooperating institutions in Philadelphia are designing new courses in science and cognitive psychology for inclusion in a new five year program leading to teacher certification. Louisiana is experimenting with ways to encourage campuses throughout the state to design programs which answer the needs of each institution but are integrated into the overall state plans for reform of mathematics and science education. Maryland is pioneering ways to use telecommunications to facilitate joint curriculum reform throughout the state and has integrated an interesting set of research laboratory and science museum internships for pre-service teachers. Montana is concentrating on introducing hands-on science courses and the Harvard calculus model throughout the state university system. The project has expanded its outreach to include seven tribal colleges within the state and many model school sites with a high population of Native Americans.

Teacher Preparation Supported Through Other Division of Undergraduate Education Programs

Proposals that seek to improve the science, mathematics and technical preparation of prospective teachers are given high priority in all DUE programs. Projects with a focus on teacher preparation benefit from and add to the research base concerning student learning of SME&T. Supported projects may affect courses specifically designed for pre-service teachers or courses in which prospective teachers are part of a larger student population. The **Advanced Technological Education (ATE)** program supports initiatives which benefit students seeking preparation as technicians in science and engineering fields. Included are projects to prepare teachers for secondary and associate degree level technological education. Design of new courses or modification of existing courses is supported by the **Course and Curriculum Development (CCD)** program. The **Instrumentation and Laboratory Improvement (ILI)** program supports the purchase of laboratory equipment and exemplary use of laboratories. Workshops and educational activities for faculty concerned with science, mathematics, engineering, and technology courses which enroll prospective teachers are supported by the **Undergraduate Faculty Enhancement (UFE)** program.

Projects supported in FY 96 feature: courses and curricula in mathematics, engineering, and the sciences; students preparing to be elementary, middle, and secondary teachers; and recruitment of undergraduates to teaching careers. A great range of activities is represented by these projects. A CCD project at Duke University is developing a pilot program for encouraging engineering students to enter and become certified for secondary school teaching careers. At San Diego State University, a series of biology modules combining hands-on activities and computer-based activities for use with prospective elementary school teachers is also being developed with CCD program support. This work includes the creation of laboratory exercises to promote understanding of fundamental ideas in evolution and ecology.

Of the numerous ILI projects receiving teacher preparation funding, many provide equipment which supports courses primarily enrolling pre-service teachers and include the use of technology in ways that

Introduction

model how students will use it in their future school settings. Laboratories to support such courses are being developed at the College of Notre Dame (MD) (chemistry), University of Evansville (IL) (interdisciplinary), Harris Stowe State College (MO) (life sciences), Southwestern Missouri State University (mathematics), and Portland State University (OR) (geosciences), among others. As part of an innovative ILI project in interdisciplinary science at Grand Valley State University (MI), undergraduate science majors and prospective science teachers design and carry out experiments aboard a floating laboratory and classroom. This vessel, the *W.G. Jackson*, is also used as a regional science resource at various port cities around Lake Michigan. At the University of Northern Iowa, laboratory facilities are being upgraded to include Computer-Integrated Manufacturing technology with full-sized machine tools. Access to this equipment will improve the laboratory experiences for students preparing for technician teaching careers.

A UFE project at the University of Southern Mississippi hosts workshops for two-year college faculty who teach mathematics courses for pre-service elementary teachers. The workshops provide experience with approaches to mathematical content and pedagogical activities called for by the National Council of Teachers of Mathematics (NCTM) Standards.

The focus on teacher preparation is also evident in the large, comprehensive projects funded by DUE in FY 96. In the *Systemic Changes in the Undergraduate Chemistry Curriculum* initiative, a new project at the University of California, Los Angeles addresses the preparation of primary and secondary science teachers by involving them as active participants in the lower division courses of the molecular science curriculum. By working with the modules, associated learning methods, and electronic delivery system that undergird the project, these students obtain a practical perspective on science teaching as well as the ability to utilize current technology to direct learning activities. All four projects funded in the *Mathematical Sciences and their Applications throughout the Curriculum* initiative receive partial funding for teacher preparation activities. An important component of the project spearheaded by the State University of New York at Stony Brook involves faculty reworking all aspects of the curriculum for future mathematics teachers to reflect the needs of the NCTM Standards. Likewise, the comprehensive curricular reform projects led by Indiana University, the Consortium for Mathematics and its Applications, and the University of Nebraska include attention to the needs of pre-service teachers.

Two ATE centers include a focus on teacher preparation. An important component of the South Carolina Advanced Technological Education Center of Excellence features efforts at Clemson University and other four-year colleges to help prepare the middle and secondary school technology teachers of the future. The Maricopa Advanced Technology Education Center (MATEC), which is focusing on technician education for advanced semi-conductor engineering, is partnered with Arizona State University to help prepare the grades 7-12 school teachers of tomorrow.

Continuing Projects: All four projects begun in FY 95 in the *Systemic Changes in the Undergraduate Chemistry Curriculum* initiative (based at Beloit College [WI], University of California at Berkeley, University of Wisconsin at Madison, and at City University of New York's City College) include a focus on teacher preparation with activities and learning experiences designed specifically for teachers, as well as providing a model for teaching chemistry using current pedagogical techniques. All three projects funded in FY 95 in the *Mathematical Sciences and their Applications throughout the Curriculum* initiative receive partial funding from teacher preparation. At Dartmouth College (NH) and the University of Pennsylvania, sweeping interdisciplinary curriculum reform based upon the learning and applications of mathematics at all levels of the undergraduate curriculum includes attention to the needs

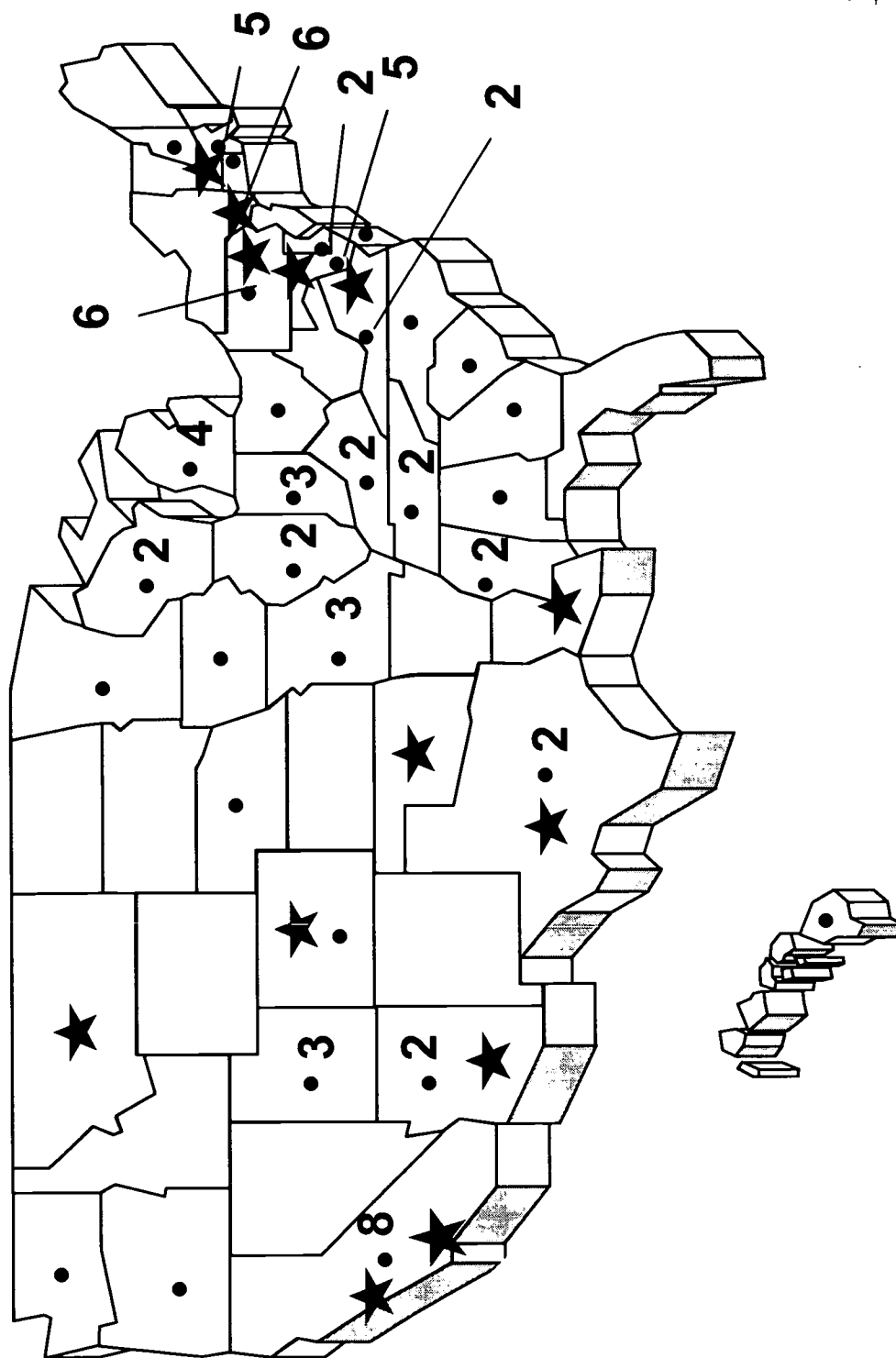
of prospective teachers. Input is included from expert consultants and practicing teachers. The project based at Rensselaer Polytechnic Institute (NY) includes a significant teacher preparation component at two partner schools, the University of Delaware and Siena College (NY).

Two other ATE Centers for Excellence also include a focus on teacher preparation: At Chemeketa Community College (OR) an important activity of the Center is a program to prepare teachers of technology for high school programs and the Center at Middlesex County College (NJ) is working with Trenton State College's technology education program to prepare secondary teachers for the schools of tomorrow.

Workshops and Conferences

In FY 96, DUE supported two working conferences devoted to teacher preparation issues. In early February of 1996 the Council for Chief State School Officers convened a symposium to consider improvements in teacher preparation and teacher credentialing in light of the National Research Council's recently released National Science Education Standards. This symposium was jointly supported by NSF (the Division of Undergraduate Education and the Division of Elementary, Secondary and Informal Education) and the National Research Council Fund. Participants included nearly forty state teams comprised of higher education faculty, school superintendents and administrators, and representatives of other stakeholders in K-12 education. In March of 1996 the American Association for the Advancement of Science conducted a Dean's Forum to consider how to design, develop, and implement university-based collaborative efforts to improve teacher preparation programs. Most of the participants attended as teams of two, which paired deans of science with their cross-campus counterparts in education.

Map of National Impact: FY 96 CETP/TP Collaboratives and Projects



★ CETP Collaboratives ● Teacher Preparation projects

**National Science Foundation
Directorate for Education and Human Resources
Division of Undergraduate Education**

PROJECT DESCRIPTIONS: FISCAL YEAR 1996

**NSF COLLABORATIVES FOR EXCELLENCE
IN TEACHER PREPARATION (CETP)
FULL COLLABORATIVES FOR FY 96**

The San Francisco Bay Area Collaborative for Excellence in Teacher Preparation

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DUE-9553786
\$5,000,000

The San Francisco Bay Collaborative for Excellence in Teacher Preparation, led by San Jose State University and San Francisco State University, identifies and establishes a core group of incoming freshmen – especially from underrepresented groups – who are interested in becoming teachers. Major components of the program are: 1) recruitment of future teachers from several target populations; 2) attention both to science and mathematics majors preparing for secondary school teaching and to students entering elementary school teaching; 3) extensive early field experiences; 4) tutor-mentor-advisor programs; 5) workshops for science and mathematics faculty resulting in their significant involvement in curriculum reform; 6) revision of core science and mathematics courses and creation of innovative capstone/integrated courses; and 7) a support network for new science and mathematics teachers. The project affects approximately 4000 students per year.

Virginia Urban Corridor Teacher Preparation Collaborative

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DUE-9553789
\$5,000,000

The Virginia Urban Corridor Teacher Preparation Collaborative is a joint effort of the liberal arts, science, and education faculties of universities and colleges that train the large majority of prospective teachers within Virginia's urban corridor (Longwood College, Mary Washington College, Norfolk State University, and Virginia Commonwealth University), the region's Community Colleges (Germana, J. Sargeant Reynolds, and Tidewater), the Virginia Mathematics and Science Center, and the regional school systems. The goal of the Collaborative is to implement programs that will prepare K-8 teachers

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who have strong science and mathematics backgrounds, who enjoy science and mathematics, who understand what is known about the types of teaching that enable students to learn, and whose teaching will reflect their scientific and pedagogical knowledge. All science and mathematics courses taken by prospective K-8 teachers are being renewed and reformed by adapting the “best practices” being developed nationwide. Course revision teams include faculty from scientific disciplines, education departments, and master teachers from the school systems. A cadre of clinical faculty (outstanding K-12 teachers) play a crucial role in all aspects of teacher preparation reform, including the in-school experiences of prospective and new teachers and the professional development of discipline faculty. Recruitment and retention efforts enlist pre-service students to work with the faculty as Teaching Associates. The Collaborative will also include three cross-fertilization/dissemination activities: an annual week-long science and mathematics colloquium; an annual four week long institute featuring courses which are being developed by Collaborative institutions, and a published journal devoted to the preparation of prospective K-8 teachers in science and mathematics. This Collaborative will impact policies required for preparation of K-8 teachers, improve the nature and quality of instruction in mathematics and the sciences, improve in-school experiences of prospective teachers, enhance recruitment of qualified teachers of science and mathematics (particularly for underrepresented groups), and promote the dissemination of materials and approaches within the Collaborative and beyond.

Recruitment, Training, and Retention of Oklahoma Science and Mathematics Teachers

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DUE-9553790
\$5,000,000

The Oklahoma Teacher Education Collaborative (O-TEC), a consortium composed of K-12 schools and two-year, and four-year institutions from across the state addresses concerns in the teacher preparation system, from recruitment through pre-service training and into the early years of teaching. A series of summer academies recruits talented youth from under-served populations and allows potential teachers to work under the direction of classroom teachers to present model lessons in science and mathematics. Activities at two-year institutions of higher education feature the development of courses articulated with four-year institutions and formulation of a curriculum for para-teachers. Engineering faculty are participating in development of general education courses that are appropriate for teachers, and particular attention is given to retention of new teachers and their professional growth during the early years of teaching. O-TEC is training experienced teachers and building administrators to provide support in science and mathematics teaching through state entry-year committees. A summer in-service program brings new teachers together after their first year to share experiences and address concerns about content and pedagogy. O-TEC sponsors sessions for entry-year teachers at meetings of the Oklahoma Science Teachers Association and Oklahoma Council for Teachers of Mathematics to encourage professional participation. O-TEC institutions also provide consulting for entry-year teachers who experience difficulty and provides some equipment to new teachers. Use of technology is a component of all activities and several modes of evaluation provide feedback for guidance.

CETP FY 96 DEVELOPMENT GRANTS

Alabama Strategic Teaming for Advancing the Readiness of Teachers

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DUE-9553782
\$100,000

This project is a joint effort of the University of Alabama at Birmingham (UAB), Auburn University (AU), the University of North Alabama (UNA), and Miles College (MC) featuring intra- and inter-institutional course development. As an example of the former, an innovative course for pre-service teachers at UAB, developed and taught by a faculty member in Materials Engineering and a faculty member in Education, is being disseminated to other institutions. The project supports an analogous effort involving UAB faculty from Chemistry and Education targeting General Chemistry. For inter-institutional course development, projects are being developed that pair Auburn University and Tuskegee Institute, UNA and Alabama A&M, and Miles College and UAB in efforts to improve their teacher preparation programs in the sciences, mathematics, or engineering.

Hawaii Project for Excellence in Science and Mathematics Education

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DUE-9553783
\$99,953

The project is developing, testing, and evaluating a small-scale model for effective team efforts to reform science and mathematics preparation for pre-service elementary teachers in the University of Hawaii system. The project brings together scientists and mathematicians from the University of Hawaii at Manoa (UHM) and Kapiolani Community College as well as within the University of Hawaii and specialists and in-service teachers from the Hawaii Department of Education. The project aims to restructure four existing courses to: 1) reflect reforms in science and mathematics content, teaching, and assessment standards; 2) better integrate science and mathematics in these courses; and 3) better articulate these content and education courses.

Delaware's Innovative Science/Mathematics Program for Undergraduate Success

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DUE-9553787
\$100,000

A core group of mathematics and science content and education faculty from the University of Delaware, Delaware State University, and Delaware Technical Community College are working with K-12 teachers in an initial effort to reform 10 existing courses that make up parts of the pre-service teacher preparation

FY 96 Awards

programs at these three institutions. Work is also planned on three new courses for in-service teachers. In this project K-12 teachers will work with higher education faculty, leading to the development of a K-16 community of mathematics and science educators dedicated to the continual improvement of its pre-service teacher preparation programs. These reform efforts also leverage the considerable momentum towards reform engendered by the Delaware State Systemic Initiative project.

ADVANCED TECHNOLOGICAL EDUCATION (ATE) PROGRAM

South Carolina Advanced Technological Education (SC ATE) Center of Excellence

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DUE-9602440
\$5,000,000
Engineering Technology

The SC ATE Center is creating a learning environment which models the new technologically sophisticated work environment. Objectives are focused in three broad areas including curriculum reform, program improvement, and faculty development. Curriculum reform centers on developing integrated engineering technology core curricula using a systems-based approach. Program improvement encompasses recruitment/retention reforms as well as the development of an electronic communications infrastructure for state-wide curriculum design and delivery. Faculty development emphasizes the use of interdisciplinary/intercampus teams for designing and implementing curriculum reforms. The primary target audience of the SC ATE Center is technical college students enrolled in, or desiring to enroll in, engineering technology programs with a particular emphasis on attracting women and underrepresented minorities. The Center seeks to impact the educational pipeline from middle school through the baccalaureate level. A particular emphasis involves working with Clemson University and other four-year colleges to help prepare the middle and secondary school technology teachers of the future. Collaborative partnerships encompass over 25 educational, governmental, and business/industrial entities including the State Department of Education, Clemson University, South Carolina State University, the Virginia Community College System, the Governor's Mathematics/Science Advisory Board, the Governor's Commission on Women, the South Carolina Department of Commerce, AMP Incorporated, Bell South Telecommunications Incorporated, Michelin North America, Bose Corporation, Robert Bosch Corporation, and NCR Corporation. A strong evaluation component, headed by the Academy for Educational Development, facilitates the development of program improvement processes and curriculum products that will have a significant impact on engineering technology education nation wide.

Maricopa Advanced Technology Education Center in Semiconductor Manufacturing and Related Fields

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DUE-9602373
\$4,591,327
Semiconductor Manufacturing

The Maricopa Advanced Technology Education Center (MATEC) is operated by the Maricopa County Community College District, the nation's second largest community college system with 90,000 students. Maricopa is partnering with: 10 semiconductor manufacturing/supporting industry companies including Intel, Motorola, SGS-Thompson, and Microchip Technology; two Tech Prep consortiums with 13 secondary school districts (60,000 students); Arizona State University, the nation's largest public university (43,000 students); three other Community College Districts in Arizona and Oregon; and Albuquerque Technical-Vocational Institute. The primary objectives of the Center are to: 1) create new curricular systems/materials which reduce the disparity between what is taught and learned in schools and what is needed by technicians in semiconductor manufacturing/related supporting industries; 2) provide technical support, instructional support, and access to resources that faculty/trainers who are preparing students for careers as technicians need to ensure continuing relevance to workplace needs; and 3) increase the number of students, especially women and minorities, who prepare for and become employed as technicians in the semiconductor manufacturing/supportive industries. Targeted programs are Semiconductor Manufacturing/Processing Technology, Circuit Design Technology, and Facilities Maintenance Technology. MATEC's three components are: Curriculum/Materials Development, Staff Development/Support, and Workforce Development Support. Examples of strategies are Computer-Based Instructional Design System, Continuous Quality Curriculum System, Multimedia "Virtual" Materials, Electronic Resource Center/Form, On-line Q/A, Faculty Internships, Scholarships, and Workshops/Seminars for a national audience. Outcome evaluation uses a gap reduction model with measurement instruments to be developed by American College Testing based on specific job profiles of skill levels necessary in workplace. There is also work with Arizona State University to help prepare the secondary school teachers of tomorrow for programs in grades 7-12 that ensure the students who enter advanced technology programs are prepared to succeed. The Center is closely coordinating its work with the Phoenix Urban Systemic Initiative and the Arizona State Collaborative for Excellence in Teacher Preparation.

COURSE AND CURRICULUM DEVELOPMENT (CCD) PROGRAM Systemic Changes in the Undergraduate Chemistry Curriculum

Molecular Science

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DUE-9555605
\$2,425,000
Molecular Science

Representing 24 area community colleges that have worked together for more than 15 years, the University of California at Los Angeles (UCLA), California State University at Fullerton (CSUF) Community College Alliance is restructuring the lower division chemistry curriculum and the auxiliary

learning and assessment processes. The new curriculum adopts a constructivist approach, emphasizing problem solving and exploratory learning. The new Molecular Science Curriculum cuts across departmental and disciplinary boundaries to embrace all activities that involve the study of atoms and molecules. In particular, environmental science, materials science, and molecular life science have important positions in the new lower-division chemistry curriculum. The new curriculum reflects current practice in research and the chemical industry. Materials being produced include: problem-based molecular science modular learning units; data sets for exploratory learning; prepackaged molecular, mathematical, and schematic models to illustrate important principles and phenomena; and a client/server system that manages educational data. The learning units will be used in the technology programs of several of the community colleges, such as those for science technicians and hazardous materials technicians at Mount San Antonio Community College. New assessment vehicles including cumulative electronic portfolios of group and individual work providing new insight into student development and potential are also being developed.

The CSUF project also addresses the preparation of primary and secondary science teachers by involving them as active participants in the lower division courses of the molecular science curriculum at both UCLA and CSUF. At both UCLA and CSUF, these students will gain experience with the modules, associated learning methods, and the electronic delivery system. These experiences are designed to produce teachers with a practical perspective on science teaching as well as the ability to utilize current technology to direct learning activities. The electronic delivery system allows students at UCLA to work with the science education faculty at CSUF to obtain certification. Two high schools (Aliso Niguel and Crossroads) are also members of the Alliance.

COURSE AND CURRICULUM DEVELOPMENT (CCD) PROGRAM Mathematical Sciences and their Applications throughout the Curriculum

Long Island Consortium for Mathematical Sciences Throughout the Curriculum

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DUE-9555401
\$ 2,799,820

A consortium of faculty at ten colleges and universities on Long Island, in conjunction with the State University of New York (SUNY) system, is designing a comprehensive, multi-faceted project to develop an environment for interconnected learning in mathematics courses and in mathematically based disciplines. Headquartered at the State University of New York at Stony Brook, other institutions of the consortium include: C. W. Post College, Dowling College, Nassau Community College, New York Institute of Technology, St. Joseph's College, Suffolk Community College, SUNY Agricultural and Technology College at Farmingdale, SUNY College at Old Westbury, and CUNY York College. The model for interconnected learning developed on Long Island is being extended to SUNY-wide implementation (64 institutions), and is being actively disseminated to other institutions inside and outside New York state. The enhanced learning environment has three components: 1) systemic change in instructional practices; 2) creation of new courses and curricular materials; and 3) development of human resources. The connections in this project involve: collaboration and cooperation in instruction among faculty across quantitative disciplines; regional networking of energized faculty at different types

of institutions; and the enhanced effect of combining change in modes of instruction with curricular reform, educational technology, and coordination of instruction among departments. Major project activities include:

- Changing modes of faculty instruction and student learning;
- Day-to-day and general coordination of instruction across the curriculum;
- Extensive use of educational technology across the curriculum;
- Completing reform throughout the calculus sequence and undertaking reform before calculus;
- Reworking all aspects of the curriculum for future mathematics teachers to reflect the needs of the NCTM Standards;
- Developing new multidisciplinary courses;
- Addressing student needs in Advanced Technological Education programs such as engineering and science technology through the development of appropriate mathematics courses and other mathematically oriented materials;
- Assisting groups that are underrepresented in quantitative disciplines; and
- Developing unified courses in statistics and other mathematical sciences topics now taught in multiple departments.

This project for systemic change involves an extensive organizational structure with: 1) departmental teams at each institution; 2) institutional coordinating committees; 3) consortium-wide disciplinary committees; and 4) task forces for specific projects such as development of new courses.

Multimedia Mathematics: Across the Curriculum and Across the Nation

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DUE-9555404
\$946,394

The goal of this consortium project, led by the University of Nebraska and Oklahoma State University, is to integrate the teaching and learning of mathematics and its applications in science, engineering, and quantitative subjects. This will be accomplished through a modern curriculum that provides students with a holistic view of mathematical science coherently tying together fundamental concepts from many disciplines. A critical success factor is a communication structure bringing together educators from many disciplines to share ideas, goals, and strategies. The project will also put in place services and materials that encourage experimentation with and development of curricular innovations as well as new modes of presentation. From the outset, the program will focus on the needs of many students from many disciplines and backgrounds; an especially important group will be those students preparing for careers in K-12 teaching. The implementation plan provides for students who change majors or institutions and it will be easily adaptable to other colleges and universities.

The primary product of the Oklahoma-Nebraska Consortium will be an enduring, integrated core mathematics, science, and engineering curriculum based on a collection of cross-curricular, multimedia mathematics learning module clusters. Each module will be a topic or application in itself, but it will also be part of a larger vertical and horizontal structure. The idea is to draw together and focus horizontally on concepts from other disciplines that fit naturally with fundamental mathematics concepts learned at

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the same time. Vertically, students revisit topics on more than one occasion and in more than one course, showing the power of mathematics as it unfolds. Thus in a given course, the student witnesses several applications of a single mathematical idea, but over several years he or she also encounters a particular application several times with increasing mathematical sophistication. This structure provides motivation for mathematical development, an appreciation for topics students are currently studying, and an understanding of how fundamental ideas from many disciplines fit together.

Multimedia – here defined broadly to include computer algebra, graphing software, graphing calculators, television, interactive digital video, CD-ROMs, and Internet connections – serves both as a device for focusing attention on changes that are needed as well as a vehicle for making them. The consortium schools will combine their strengths in this area throughout the program to establish new and more effective presentations and expand the range of applications that are accessible to students.

Mathematics and Undergraduate Education: A New Framework for Mutual Invigoration

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DUE-9555408
\$2,800,000

The project is an Indiana University System effort to restructure the ways in which mathematics relates to the rest of the undergraduate curriculum. The collaborating institutions are IU-Bloomington, Indiana University-Purdue University Indianapolis (IUPUI), IU-East, IU-Kokomo, IU-Northwest, IU-South Bend, IU-Southeast, and IUPU-Fort Wayne.

The ultimate goal of the project is to create a new framework for collaboration between mathematics departments and the faculties of other disciplines, as well as a new culture among undergraduates that will revitalize the learning of mathematics and reinvigorate undergraduate education. A particularly important audience is the pre-service teacher population. There are three interrelated objectives: 1) To create interdisciplinary courses in which students learn new mathematical ideas and acquire new tools through contextual problem solving and that involve the cooperation of the mathematics faculty with other faculty from a variety of disciplines; 2) To change student attitudes about mathematics by developing an academic and social infrastructure to encourage all students to see the relationship to other subjects, the real world, and their own personal ambitions and goals; and 3) To change the academic infrastructure in order to make permanent positive changes in the teaching and learning of mathematics on these eight Indiana University campuses and beyond.

Project Inter-Math

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DUE-9555414
 \$2,000,000

The project is developing programs where students learn skills in computing, writing, reasoning, and problem solving. Its vision is to establish environments conducive to interdisciplinary cooperation for designing and presenting instruction in all partner disciplines. Interdisciplinary projects are being used as a vehicle to move from disconnected mathematics courses to a fully integrated experience in all partner disciplines. Teams at each institution consisting of faculty from several disciplines are collaborating to develop course materials, termed Interdisciplinary Lively Applications (ILAP). A core set of ILAP materials has already been developed primarily at West Point and has been implemented over the past several years. Several types of ILAPs are envisioned, beginning with the basic ILAP project and culminating in ILAP carry-through projects. Workshops are also being conducted that enable faculty to use projects, design curricula, model student growth, and present "lively" pedagogy.

The consortium is representative of all types of the nation's undergraduate institutions: two-year colleges, liberal arts colleges, engineering schools, historically black colleges, and research universities. Through the joint efforts of the institutions involved, the project is affecting thousands of undergraduate students by making a lasting cultural change with the national dissemination of our activities. The ultimate goal is to develop an interdisciplinary culture that acts like a pump, sending students into mathematics, science, and engineering.

COURSE AND CURRICULUM DEVELOPMENT (CCD) PROGRAM

Standard Projects

Long-Term Field Studies for Undergraduate Education: A Snapshot in Time

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DUE-9554807
 \$242,000
 Life Sciences

A long-term field experiment to improve undergraduate teaching in ecology and environmental science is being incorporated into undergraduate courses. The experiment is designed to address topics of ecological succession contrasting the effects of mowing and fertilizer treatments in upland and lowland abandoned farm fields. Elementary, middle and secondary school pre-service and in-service teachers, and students taking courses in Southern Illinois University's Environmental Studies Program (as a minor for a wide range of major degree programs) participate in the design, implementation, data collection and analysis of the field experiment. Students participating in the experience assess the advantages, disadvantages and limitations of field experiments, better appreciate the role of scientific research in understanding the natural world, and are better able to describe and articulate one of the most important ecological processes: succession. Incorporation of the field experiment into appropriate courses is creating models for other national and international programs.

A School-University Partnership Through Distance & Service Learning

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\$82,273
Physics

This distance- and service-learning project at Virginia Polytechnic Institute is a partnership between the University's Physics Department and science programs at high schools throughout Southwest Virginia. Two related problems are targeted: 1) the geographic and professional isolation of rural high schools and teachers; and 2) the academic isolation of advanced undergraduate and graduate science students who have little or no opportunity to communicate with populations outside of their highly specialized scientific field. The project employs distance learning to stimulate high school students' interest in and appreciation of rapid developments in the fields of physics and astronomy, and service-learning to engage selected physics students in the delivery of this information through ongoing electronic and face-to-face interactions. As piloted with Floyd County High School, the project is designed to: increase the level of science literacy among the general population of students at Floyd County High School; lead to the creation of an Advanced Placement Physics course; improve the oral, written, and electronic communication skills of physics majors at Virginia Tech; and introduce physics majors to new applications of their discipline, including careers in teaching. All phases of the project pilot will be carefully documented, leading to the production of a teaching guide for school-college collaborations using distance- and service- learning techniques.

Certification of Engineering Students for Teaching in Secondary Schools

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DUE-9554898
\$19,264
Engineering

This project investigates the feasibility of creating a pilot program for the certification of engineering students for teaching in secondary schools. Given the complexity of secondary teacher certification, the development of a pilot program for engineering students is a challenging task. The project represents the results of preliminary discussions with the North Carolina Board of Education, representatives of the Duke teacher certification program, and the Duke University Master of Arts in Teaching program, indicating that the development of a model requires extensive discussions and evaluations. The project is undertaking the task of developing a comprehensive and useful pilot program for encouraging engineering students to enter secondary education.

An Integrated Mathematics-Engineering Course for Non-Science Students

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DUE-9554913
\$129,991
Mathematics

The project involves the design of an integrated two semester general education course in mathematics and science. The project's main goal is to convince non-science students that they can enhance their grasp of the outside world using elementary calculations and data acquisition. There are two primary activities: 1) revision of a first draft of the mathematical material, relying on results of pilot testing with undergraduates at the College of William and Mary and Norfolk State University and with in-service teachers at 10 university sites across Virginia; and 2) construction and piloting of the physics/engineering portion of the material, which directly references the mathematics encountered by students in the first term. Pre-service teachers (primarily elementary and middle school) are particularly affected, since they make up a large part of the enrollment in this sequence. The central theme of the mathematical material is the use of real data. The problems bear directly on an intuitive grasp of a particular physical setting – powered aircraft flight – and the data gathered include: daily wind data, wind histories, navigation maps and runway plates, weights and dimensions of commercial aircraft, and current magnetic declination data. Computations involve arithmetic, elementary algebra, some geometry, some trigonometry, and some use of hand-calculators for numerical integration. The engineering/science part of this work requires students to obtain some of these data themselves, with a view to getting information that is crucial to the proper function of aircraft. Appropriate experiments to test physical laws that are important to flight are also being designed and tested.

Hands-On Activities for Developmental Mathematics Courses

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DUE-9554939
\$145,344
Mathematics

This project is developing a collection of hands-on activities that support introductory college mathematics at the elementary algebra, intermediate algebra and precalculus levels. The units particularly support older students who are coming back to school by including materials that convey mathematics within the context of engaging applications and interesting problems. Applications from physics, economics, biology, genetics, and other areas of interest to students provide a context for the mathematics. The materials support a cooperative learning style, with the students doing hands-on group activities during much of class time. These activities help students visualize mathematics and make connections between mathematics and the real world. Particular attention is paid to developing materials for students in teacher preparation programs and for the faculty who work with these pre-service teaching majors. Many mathematical topics will be integrated into each application. The materials are supported by the use of spreadsheets and the TI-82 calculator. To ensure accuracy, practitioners in a variety of fields will be consulted.

Revitalizing Undergraduate Number Theory

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DUE-9554970
\$79,542
Mathematics

This project is developing and implementing (at Michigan Technological University and Arizona State University) course materials for an improved undergraduate number theory course. The new course incorporates many of the ideas and innovations that have been successfully employed in earlier mathematics education reform projects. New features integrated into the course include: the use of guided discovery as the primary mode of student learning; the use of *Mathematica* to facilitate numerical experimentation; collaboration between students to work on forming and investigating conjectures; a diminished emphasis on lectures; and student laboratory reports detailing results that have been obtained. The target audience for the proposed course is pre-service secondary mathematics teachers, who comprise the majority of students in the course. Materials being prepared include: pre-laboratory worksheets and homework assignments; *Mathematica* notebooks; documents to be distributed to students that describe the nature of the course and expectations for laboratory reports; and an instructor's guide to assist in implementation at other sites. All materials will be free and available to interested parties via anonymous ftp.

A One-Quarter, Inquiry-Based Physics Course for Pre-Service Elementary Teachers Using Gender-Neutral Course Materials

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DUE-9555017
\$61,040
Physics

A revised introductory physics curriculum for pre-service teachers, particularly those at institutions employing the quarter system, features a series of hands-on activities and exploration/research projects and includes historical and current biographical material on scientists of both sexes and a diversity of racial backgrounds. The activities focus on areas – such as health and the environment – that have been shown to be of concern to students, particularly women. Effectiveness of the curriculum for both male and female students is being tested in the classroom and results will be disseminated in the literature and through electronic media. A final version of the curriculum will be made available through a publisher for general adoption.

Implementing the Standards for Introductory College Mathematics Before Calculus

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DUE-9555059
 \$120,014
 Mathematics

Standards for Introductory College Mathematics Before Calculus was developed with funding from the National Science Foundation and the Exxon Education Foundation to address the special needs of, establish standards for, and make recommendations about introductory precalculus college mathematics. The standards provide goals for introductory college mathematics and guidelines for selecting content and instructional strategies for accomplishing these goals. The goal of the project is to facilitate the implementation of the Standards. This is being accomplished by holding four regional workshops with the intention of: 1) informing a wider audience of the reform issues and proposed patterns and models for improving curriculum and instruction; 2) encouraging the formation of consortia of two- and four-year colleges and universities in each of several regions, which will continue to work on implementation projects; 3) reviewing current exemplary programs, materials, and activities at the introductory college mathematics level as well as relevant secondary programs based on the NCTM Standards; 4) providing workshop participants with information on relevant research in mathematics education, effective approaches to change, and suggestions for working with their administrations to provide effective mathematics education for their students; 5) preparing a compilation of reports on the implementation projects begun as a result of the regional workshops; and 6) making information on the AMATYC Standards available to all members of the mathematics community. The workshops are enabling faculty and administrators to: learn about successful programs that embody the Standards; observe or experience the process of learning through working in groups, in a laboratory setting, and/or using technology; and engage in active learning processes recommended by the Standards.

WWW and Internet Dissemination of Biology and Computer Labs for Prospective Elementary Teachers and of a Biology Test for Conceptual Understanding

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DUE-9555089
 \$150,000
 Life Sciences

This project is: 1) disseminating, via the World-Wide Web and the Internet, a series of biology modules for prospective elementary school teachers, each of which includes a hands-on laboratory activity, a computer-based knowledge-construction activity, and a Teacher's Guide; 2) developing, disseminating, and assessing a multiple choice test for the conceptual understanding of biology useful for testing prospective elementary school teachers, biology majors, and non-science majors; and 3) developing, refining, and testing several new biology laboratories designed to develop an understanding of evolution and ecology through in-class studies of population.

The biology modules aim to build competence and dispel alternative misconceptions in three areas: 1) Molecular (particulate theory of matter, diffusion, osmosis); 2) Organismal (body systems including circulatory, respiratory, digestive, and excretory); and 3) Population (concepts embedded in evolution including genetic variation, natural selection, competition, producers, food webs, and predation). Each

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demonstration biology laboratory is accompanied by a knowledge reflection activity supported primarily by *SemNet* software. The *SemNet* software will be distributed via a server established by SDSU. The multiple-choice test challenges students' conceptual understanding of biology. Students are asked to interpret items such as a brief description of a laboratory exercise, including graphical representation of results. Open-ended responses obtained initially are converted to multiple choices in which distracters represent commonly given misconceptions. The new biology laboratories are designed for use by undergraduate instructors of prospective elementary teachers, undergraduate education majors, pre-service and practicing teachers, and other interested persons.

The Complete Geography: A Model Curriculum for Pre-service Teachers in Cultural, Physical, Techniques, and Regional Geography

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DUE-9555091
\$200,000
Geography

A four-volume manual of module exercises covering each of the four core areas of geographic education – cultural, physical, geographic techniques, and world regional geography – is being developed by teams of geographers, education faculty, technology consultants, and an advisory committee. The 'Cultural' and 'Physical' volumes are being produced in the first year, and the 'Techniques' and 'World Regional' volumes in the second year. The manual will be tested by an advisory committee for its consistency with the philosophies and objectives of *GEO-Teach*, a pre-service geography education program funded by FIPSE and currently being implemented at Mankato State University. *GEO-Teach* strives to model for students successful approaches to interdisciplinary teaching and a content- and process-based pedagogy that integrates up-to-date technology instruction into the curriculum; it is expected that the same principles will be integrated into this four-volume manual. Two external evaluators will conduct testing in large and small university classes outside Mankato State University. It is anticipated that the final product will be available for distribution to other pre-service geography/social studies programs in the spring of 1998.

Cryptography, The Science of Secret Writing: An Innovative Approach to Introductory Mathematics for Non-Science Majors

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DUE-9555113
\$70,000
Mathematics

This project is designed to refine a course and develop a text in cryptography – the science of designing methods to disguise secret messages. The goal is to provide an innovative alternative in introductory mathematics for beginning non-science majors as well as students preparing for certification in elementary and high school mathematics. This course is serving to replace more traditional beginning courses such as college algebra and trigonometry and finite mathematics, and is appropriate for all entering college students. The course covers classical cipher systems (systems used during World Wars I and II, for example), modern encryption systems, and error-correcting codes. Some topics presented in the text are: substitution

ciphers, transposition ciphers, the RSA Algorithm, digital signatures, the Knapsack Algorithm, and one-way functions used for personal identification number (PIN) security. Mathematical topics to be presented at the beginning level include: modular arithmetic, probability and statistics, matrix arithmetic, number theory, and combinatorics. In an active learning environment utilizing technology, these mathematical tools are used to guide students in the breaking and constructing of cipher systems and in determining the strength and utility of ciphers. The project is being disseminated via a preliminary manual for the course to selected institutions that are beta testing the materials in classes, presentations at national meetings, and preparation of a text for commercial publication. An experienced evaluation team is providing an intensive evaluation of the project.

Lie Theory and Continuous Symmetry in the Undergraduate Curriculum

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DUE-9555134
\$174,788
Mathematics

The course being developed exhibits the unifying nature of continuous symmetry. The course begins by discussing symmetries that are directly related to concepts of physical space: dilations, rigid motions, similarities. It then introduces the basic concepts of linear algebra, and discusses geometric issues in two, three, and four dimensions, culminating in the special theory of relativity. Examples and applications are emphasized throughout. The course emphasizes interactive teaching, and will include extended projects with possibilities for group activities. An important project component, one which involves pre-service teachers, is the work with PIMMS, the leading mathematics and science education effort in the State of Connecticut. A text is planned along with computer laboratory materials. The overall goal of this work is to put students in touch with a major direction of intellectual advance in mathematics over the past century, and to take the ideas of mathematics education reform further into the undergraduate curriculum. The proposed course can be an alternative to a sophomore-level linear algebra course.

The Restructuring at SUNY Cortland of Science, Mathematics, and Pedagogy Experiences for K-6 Pre-Teachers

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DUE-9555152
\$850,000
Interdisciplinary

SUNY Cortland has the largest elementary teacher preparation program in the State of New York. The current project resulted from an NSF CETP development project and is developing curriculum and instructional materials to implement a 27 credit hour block of experiences. In addition to the SUNY Cortland staff, science/mathematics faculty from five regional Community colleges are involved in the curriculum development and implementation phases of the project. A research/assessment team from Cornell University is evaluating all aspects of the project. The Level One block contains content courses specifically designed for K-6 pre-teachers and is taught using a conceptual change approach; Composition 101 is taught in conjunction with the Level One Science course. Pedagogy courses in both science and mathematics are taught in conjunction with the Level One content courses. In both

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pedagogy courses, the pre-teachers are involved in experiences with elementary school-aged students. The Level Two block is an integrated and interdisciplinary mathematics/science experience in which students are introduced to problem solving strategies and utilize the strategies to investigate six significant real world science problems. Mathematical concepts are being developed through the context of science content. During the Level Two block, pre-teachers work with elementary-aged children in a mathematics/science laboratory setting. In a culminating mathematics/science experience, the pre-teachers participate in a Science, Technology and Society (STS) block in which they are engaged in conducting real world STS research under the guidance of a faculty facilitator and a business/industry mentor. Each curricular block is pilot tested three times before the curriculum is integrated into the academic program of the host institution and that of the five satellite campuses.

LDAPS: An Innovative Solution for a Low-Cost, Exciting Laboratory Class in Engineering

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DUE-9555181
\$99,705
Engineering

This project is developing a laboratory experimentation curriculum for engineering students and liberal arts majors. Two courses are involved: an introductory class geared for first-year engineers and liberal arts students (primarily pre-service teachers engaged in teacher preparation programs), and a required junior-level mechanical engineering course. In the introductory course, students concentrate on simple experimentation techniques, learning how to interface a computer to an experiment, and how to do simple statistical analysis of the data. Students in the upper-level course learn the electronics behind the data acquisition systems, learn more in-depth signal processing, and work on oral and written skills.

The curriculum is based on the LDAPS, or Lego™ Data Acquisition and Prototyping System, which is a pedagogical technique originally developed for K-6 science education. The LDAP System uses Lego™ building blocks and a LabVIEW™ computer interface to provide the tools for students to design, build, instrument, and execute their own experiments. The building blocks give the student freedom in designing the experimental setup, while LabVIEW™ gives the signal processing freedom necessary to effectively interrogate the data. As examples; learning advanced digital filtering techniques by building a Lego™ gray-scale scanner or learning active control by building a car to drive around obstacles.

Workshop Physical Science: Project Based Science Education for Future Teachers, Citizens, and Parents

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DUE-9555188
\$183,249
Interdisciplinary

The Workshop Physical Science Project is a major effort to improve the science education of future K-8 teachers, parents, and citizens by developing a sequence of introductory laboratory courses in physical science. Guided inquiry is integrated with student-directed projects to help students acquire a better

understanding of what practicing scientists actually do. This hands-on approach is aimed at changing the focus of introductory science courses from covering a large number of topics to helping students develop science process skills that will give them the confidence to undertake future investigations independently. The modular design of the curricular materials provides ample flexibility for instructors at other colleges and universities to adapt the program to their own environments. These materials are being developed for use in teacher preparation programs, general studies courses for non-science majors, and courses designed to inspire freshmen and sophomores to pursue science as a major. Curricular materials for a two-semester course sequence will be created and evaluated. Three different institutions: Dickinson College, the University of Nebraska, and Moorhead State University in Minnesota are conducting a two-year pilot test of the materials.

The Role of Randomness in Science: An Interdisciplinary Course for Non-Science Majors

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DUE-9555194
\$450,000
Interdisciplinary

A new undergraduate interdisciplinary course in which students explore the key role of randomness in biology, chemistry, physics, and earth science is being created. Students are placed in the position of an independent investigator in order to convey a feeling for "what science really is." A version of these curriculum materials – experiments, simulations, and data analysis software – has already been developed as individual modules for high school science classes. These materials have been tested successfully in many settings, including: suburban and urban high schools in the Boston area; the classes of 35 teachers trained in a two-week summer workshop; as part of a course for liberal arts undergraduates; and as additions to existing physics, chemistry, and biology courses. The modules are being recast into a coherent one-semester course for liberal arts undergraduates. Significant features of the high school version, (i.e., a balanced combination of hands-on activities, experiments, and use of computers for modeling and data analysis), are retained; however, new topics are incorporated and more algebra is incorporated into all modules. Pre-service students participate in the development of course materials. Training workshops assist interested faculty from other institutions to incorporate these materials into new or existing courses. In addition to conventional dissemination channels, selected portions of the teaching materials will be made available on the Internet, along with student research reports, software, and teacher advisement.

Using Computer Technology and Multimedia Materials to Develop an Integrated Systems Approach to the Earth Sciences

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DUE-9555205
\$175,000
Geosciences

A series of computer modules is being developed to simulate the physical, chemical, and biological processes active in earth systems in ways not possible with traditional instructional methods. A primary focus of this project is the development of new instructional materials that provide future teachers with a

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solid knowledge base as well as an appreciation for the conduct of scientific inquiry. The computer models supplement classroom instruction by helping students visualize on scales “ranging from microns to mountains”: dynamic processes that occur over geologic time, three dimensional structures, and geologic phenomena. The goals of this multimedia project are to develop curriculum materials that: 1) focus on the physical, chemical, and biological processes at work in earth systems; 2) incorporate multiple learning approaches (hands-on activities, visual aides, three-dimensional models, and system simulations); and 3) contain relevant and integrative problem solving. These materials are part of an integrated curriculum package in which the computer modules enhance the learning process. This project is a collaborative effort sponsored by the American Geophysical Union, with field testing of the materials at the University of Arizona, Glendale Community College, and other institutions. The project will affect 2000 liberal arts and education majors per year at these institutions. A CD-ROM of the computer exercises, a laboratory manual, and an instructor's manual will be developed for national dissemination.

AT-SLICE: Advanced Technologies and Simulations for Learning about Interactions in Complex Environments

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DUE-9555211
\$448,947
Interdisciplinary

Materials, including simulations, are being developed for three research-rich, inquiry-based courses and laboratories. The materials develop students' ability to identify environmental problems, to design and implement research to study these problems, to develop functional literacy in the analysis and interpretation of data, to attain functional literacy in the application and use of advanced technologies, and to draft technical reports. In addition to preparing students for careers in environmental science, the effort benefits future K-12 teachers, since all pre-service students must take a course in environmental sciences prior to admission into the major program. The targeted courses and laboratories are based on societal environmental foci: Nuclear Waste Storage, Coal Power Plants, and Solid Waste Landfills. The consortium of five institutions has formed an Interdisciplinary Faculty Institute to review and implement the simulations. The Institute is creating an across-institution infrastructure of professional development and collaboration through curriculum seminars and practical workshops for faculty. The use of an outside content review panel of industry and government experts grounds these courses in the real world processes. The model we are developing and quantifying will be used at other institutions, especially those with populations of Native-Americans and Hispanic-Americans.

Proposal to Develop and Implement a Model Integrated Introductory Science Course

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DUE-9555216
\$100,000
Interdisciplinary

The Natural World: Explorations in Science, an introductory, integrated science course for non-science and elementary education majors, is laboratory-based and experientially driven. It is designed around four major concepts: Matter and Energy, Change and Constancy, Diversity and Order, and Interactions. The goals of the course are to provide a strong science base to students preparing to be elementary teachers by: providing broad, integrated science knowledge; fostering the development of effective process-learning skills in science; and creating a continuing interest in science. The course features extensive writing, concept mapping, guided discovery laboratory experiences, readings in the history of science, review of popular journals, use of collaborative student teams, library/Internet research, quantifying, computer modeling, problem solving, and activities to develop critical thinking skills. Collaborations include the teaming of physics, chemistry, and biology faculty with a writing specialist to create the course, and with university science education faculty to assist in project evaluation. The integrated course can serve as a model for introductory science courses at similar small colleges and at teacher preparation institutions.

Redesigning the Introductory-Level Physics Course for Non-Science Majors

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DUE-9555226
\$120,000
Physics

The introductory physics course taken by most non-science majors, including education majors, is being redesigned to use methodologies that support student-centered learning, journal writing, ethnography, collaborative learning, and the development of study skills. The project has as its objectives: 1) preparation of material for a student-centered, active learning course; 2) preparation of faculty to teach the course; and 3) enhancement of students' academic and personal self-confidence as future scientists, educators, and citizens. The course is being developed with the participation of NYC Alliance, a project of the Alliance for Minority Participation (CAMP) program. It will be disseminated to serve as a model and resource for other colleges.

Biology in a Human Context: A New Course for Non-Science Majors

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DUE-9555023
\$708,692
Life Sciences

This project improves undergraduate biology education for non-science majors in two-year and four-year colleges by creating, developing, and implementing a new and innovative year-long introductory biology

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course for non-science majors entitled: *Biology in a Human Context*. A team of faculty from all six University of Cincinnati academic units offering biology courses are working with faculty and staff from the University Center for Academic Technologies, the College of Education, the Office of Writing Across the Curriculum, and the General Education Council. The new course is a significant departure in both content and pedagogy from the existing traditional one. The course is taught by the biology faculty within their respective units, and fulfills both the collegiate and general education natural science requirements. Included are four, two-year and two, four-year colleges involving over 1,000 undergraduates annually, including students preparing to teach grades K-8. Biology majors preparing to be secondary teachers will participate as instructional assistants.

The Mathematics Teacher Development (MTD) Project

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REC-9600023
\$1,040,829
Mathematics

The Mathematics Teacher Development (MTD) project is conducting detailed study of pre-service and in-service mathematics teachers as they develop from traditional conceptions of mathematics, learning, teaching, and classroom practice towards conceptions that are consistent with the current mathematics education reform principles. The project identifies patterns of teacher development, obstacles that must be overcome by developing teacher, and key issues that emerge in the development process. The project also seeks evidence for the effectiveness of teacher education practices in addressing the particular problems of mathematics teacher education. Data analysis is from a cognitive and a social perspective and focuses on the individual as well as the collective development of the teachers involved. The project employs a research methodology that incorporates whole-class constructivist teaching experiments in addition to case studies of individual participants to study the development of the prospective and in-service teachers during and following a three-year instructional program. Central to the MTD research effort is unique, extensive, and state-of-the-art teacher development programs designed to promote in-depth development as a context for inquiry.

INSTRUMENTATION AND LABORATORY IMPROVEMENT (ILI) PROGRAM

Scientific Equipment to Improve Science Education Aboard the Vessel *W.G. Jackson*

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DUE-9650023
\$29,698
Interdisciplinary

This project is expanding the hands-on, investigative approach to science education, an approach that this department has used successfully with pre-service elementary teachers as well as K-12 students and teachers. This successful model for science education is now being extended to include the upper-division science instruction and undergraduate research at this university. The newly acquired, advanced equipment is being used aboard the new 65-foot floating laboratory and classroom, *W. G. Jackson*. Now being

constructed and equipped with basic science and safety equipment, the vessel will serve in science instruction and research for undergraduate science majors and prospective teachers. The new equipment is providing greater opportunities for these students to experience an investigative approach to science in numerous courses as well as through faculty supervised research. This equipment also provides an introduction to current technology in several areas of science and enhances student opportunities for higher level experience in experimental design, data collection and analysis, and computer modeling.

The university is making the vessel and its inventory of science equipment available as a regional science education resource. The *W. G. Jasckson* offers educational programs in various port cities around Lake Michigan. Additionally, it is expected to be used by other colleges and universities including Hope College, Western Michigan University, DePaul University, Cornerstone College, and community colleges including West Shore, Muskegon, Lansing, and Petoskey. The project will serve to convey scientific principles and techniques with greater effectiveness; enhance student understanding of how scientific data is collected, processed, and applied to environmental questions; and introduce new content into the students' aquatic science experience through their work with advanced equipment.

Field Equipment for an Interdisciplinary Course in Environmental Hydrology

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DUE-9650099
\$21,056
Geosciences

In this project, current meters, portable water laboratories, and well monitoring equipment are being used to enhance student experiences in undergraduate hydrology. Within five years, the project may benefit more than 125 students in environmental science and earth and space science education. This curriculum improvement is providing students with important experience in collecting and interpreting hydrologic data, utilizing the data in decision-making processes, and communicating technical information in practical writing assignments.

The final course project is to characterize streams draining areas of variable land-use and geology in a small drainage basin near the campus. Student teams design a study, collect data, and interpret results – their goal being to determine major factors that influence the quality of surface and ground waters in the basin. Results will be communicated in the form of poster sessions and briefings. With diverse respective backgrounds in biology, earth science, and geography, each student can contribute a unique set of skills and knowledge to the team's effort. These laboratory experiences are of particular importance to the preparation of pre-service teachers: Learning exercises in environmental hydrology will provide training in both scientific content and the process of scientific investigation that will serve these students throughout their teaching careers.

Upgrade Industrial Technology Production Laboratory to CIM Capability

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DUE-9650199
\$32,088
Engineering

This project seeks to integrate Computer-Integrated Manufacturing (CIM) technology into curriculum that is introductory in nature for the manufacturing technology student. Its objectives are to: 1) upgrade the existing production laboratory to reflect the current state of automation processes in manufacturing; 2) integrate manufacturing automation processes into the *Technology Education* (pre-service teachers), *General Industry & Technology* and *Manufacturing Technology* concentrations where CIM is part of the elective curricula rather than a requirement; and 3) improve the quality of undergraduate student research in manufacturing automation, materials testing, CAD/CAM, technology education and industrial technology through full-size machine tool technology. By purchasing an electronic engine lathe, retrofitting an existing vertical mill and purchasing a new CNC controller for an existing NC lathe, the Production Lab will have the capability to introduce fundamental CIM technology to students in Manufacturing Technology concentrations, Technology Education, and General Industry & Technology in entry level courses.

The proposed project will upgrade existing laboratory facilities to include CIM technology with full-sized machine tools. Currently, students have access to CIM technology through table-top machines in elective courses. The project will facilitate the introduction of CIM concepts earlier in the curriculum, improve laboratory experience for pre-service technology teachers, be available for student research projects requiring full-size equipment, and open an avenue for independent study requiring CNC lathe and mill projects.

Implementation of a Biology Teaching Laboratory Computer Network

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DUE-9650207
\$58,029
Life Sciences

This project supports the implementation of a biology teaching laboratory computer network that places 32 computers among four teaching laboratories, all connected to an existing departmental local area network for common access to data and programs. A graphic Internet browser is also being provided. A biology teaching laboratories network provides opportunities for students to acquire and analyze data as they perform experiments, to gain experience with instrument interfacing and statistical analysis using computers, and to learn how to present data and multimedia presentations for use in science and teaching careers. Internet connection of the network also gives students access to the wealth of programs and teaching resources available on the World Wide Web, interaction with graphics and informational databases, and access to model data that can be manipulated in the context of laboratory experiments.

The network system is being used in the laboratories for two, full-year freshman biology sequences that are taken by all of the majors at the college. Several upper-class courses, including *Basics of Microbiology I and II*, *Applied Microbiology*, *Virology*, *Plant Tissue Culture*, *Hematology*, *Ecology*, *Genetics*, *Cell Biology*,

and *Directed Research* can also use the networked computers. These courses are taken by biology, microbiology, and medical technology majors and elected by students in other majors. In addition, the network system can be used in courses that serve the biology science teacher certification program. This system influences the learning environment of approximately 515 students each year in laboratory courses and another 5 to 10 students engaged in undergraduate research. The system greatly enhances the teaching environment offered at the college by providing opportunities to meet the individual student needs in each of the curricula served. The network system also serves to prepare biologists and science teachers to use computers in learning, teaching, and research.

Electronic Total Stations for Field Applications in Geology

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DUE-9650263
\$40,855
Geosciences

This equipment grant supports curricular evolution at Portland State University by providing equipment that enhances technology innovation in field programs and trains students with modern equipment. The equipment, six Sokkia Total Stations, supports current curriculum revisions for geology majors, especially field-based courses and laboratories, and provides additional learning options for non-majors in the reform of general education requirements, including training of pre-service teachers. This modernization of the field portions of the program fosters additional major and non-major curricular options and provides for: major revisions of the *Field Methods* and *Anatomy of Landslides* courses; revised laboratories in *Applied Geophysics*, *Field Geophysics*, *Field Geology*, and *Engineering Geology*; increased undergraduate major and non-major research opportunities; and development of non-major undergraduate courses (*Geology of the Oregon Country*). Use of this surveying equipment contributes to the training of pre-service teachers by introducing the appropriate use of a modern technology, and by allowing future teachers to participate in the design and implementation of field-based class projects.

The equipment enables: development of an innovative curriculum not only in geology but also in other departments (Civil Engineering and Environmental Studies); fostering of cooperation among students as they develop strategies to accomplish tasks requiring precise location and distance measurements; and promotion of collaborations between senior and junior faculty in projects involving undergraduate education.

Middle School Mathematics Technology Laboratory

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DUE-9650279
\$40,000
Mathematics

The purpose of this project is to establish a mathematics technology laboratory in which to teach and develop curricula for two newly designed required courses in the pre-service middle school and elementary education majors. The two courses, *Foundations of Probability and Statistics for Teachers* and *Foundations*

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of *Geometry for Teachers*, are expected to serve 300 students each year and are undergoing major curriculum development for technology-based laboratory experiences.

The technology laboratory is being equipped with Power Macintosh 8500 multimedia computers, together with appropriate software and Internet access, for student use. The laboratory also contains the new TI-92 graphing and symbolic algebra calculators, together with Calculator Based Laboratory units, for “real” data collection and display. This state-of-the-art technology is being used to enable future teachers to experience: learning mathematics through cooperative problem solving on-line, collection and simulation of real data, visualization and exploration of geometric and algebraic patterns, and communication of concepts and strategies through written and verbal processes. Evaluation plans include concurrent assessment of curricula, student attitudes, and student mathematical progress as the technology laboratory is used, together with informal interactions with student teachers and their cooperating teachers.

Computing Across the Mathematics Curriculum

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DUE-9650323
\$53,273
Mathematics

This project details a three-phase plan to integrate technology into the entire mathematics curriculum using the symbolic algebra package, Maple. The first phase is the upgrading of an existing calculus laboratory to a truly interactive electronic classroom. In the second phase, the department will weave technology and Maple into the fabric of the upper-level mathematics courses, changing the complexion of these courses from “theorem-proof” to “laboratory-discovery-discussion-proof.” The final phase introduces a new course for mathematics majors pursuing teaching certification (*Mathematics and Technology for Secondary Education*). Throughout the curriculum, Maple is being used to simplify computation and as a tool for discovery. Before now, students used Maple only in the freshman calculus class. The success experienced in calculus can now be duplicated in all upper-level courses. With the new classroom/laboratory, the department has the facilities to implement a plan for “computing across the mathematics curriculum.”

Enhancement of Mapping Sciences at Murray State University

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DUE-9650412
\$52,187
Geography

The purpose of this project is to create a new interactive computer laboratory dedicated to the visualization, manipulation, and analysis of Earth Science data for MSU undergraduate students. It is important for students, as future teachers, scientists, and citizens to know how to work with and analyze quantitative data. The equipment purchased allows the Department to: 1) provide hands-on experience, education, and training for geoscience undergraduates in quantitative geography, geology, geophysics, remote sensing, Geographic Information System (GIS), and computer mapping; 2) provide more stimulating and improved learning experience through modern educational technology to students enrolled in general education and

science electives – particularly pre-service teachers and introductory geoscience students utilizing state-of-the-art hardware and software; 3) provide a more productive education and experience in the senior year for geosciences undergraduates than presently available; and 4) establish a bridge between undergraduate and graduate curricula of the Department. Geoscience introductory mapping and image interpretation courses have recently been modified to introduce students to digital image processing and GIS. The new equipment will be used in: beginning courses; a new, digital processing-based, intermediate level geoscience course; and senior courses in remote sensing/GIS/computer mapping.

The Connected Curriculum Project

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DUE-9650467
\$68,110
Mathematics

The Connected Curriculum Project (CCP) is developing materials that emphasize the unity of mathematics and the sciences. It combines hands-on experimentation with computer-based exploration using the World Wide Web and the Netscape web browser. The hypertext architecture of the Web is built on links and connections and, hence, matches curricular goals. In addition, it allows students to customize their learning, selecting examples and applications of particular interest and using “just-in-time” help that is available at the click of a button. Using Netscape to coordinate helper applications, the project creates a very interactive environment with students moving among a browser window, a CAS window, and hands-on laboratory work using the TI-CBL. The structure of CCP is open, taking advantage of the adaptability of web-based material to create a curriculum featuring the very best material from the very best teachers. This multiple, distributed authorship creates a widespread sense of ownership, the key to wide and lasting dissemination. This project will transform workstations at four sites to provide students at any of these sites with the same functionality. Students working at one of these sites will be able to work on any CCP course and to use CCP material in other courses as well. This is a cooperative effort with the faculty of Bonneville High School in the development, implementation, and assessment of materials for courses that are often taught at both the high school and college levels. The Bonneville High School site can also be an integral part of the pre-service secondary education programs in mathematics and science and a demonstration site for CCP materials for Utah high schools.

Advancing General Science Instruction at Evangel College: A Meteorology/Geology Computing Laboratory

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DUE-9650519
\$42,431
Geosciences

This project provides a state-of-the-art Internet access laboratory to advance the teaching methods currently used in the meteorology and geology laboratory courses. Meteorology and geology each represent core offerings of the general science curriculum and thus serve a large and diverse student population. This project restructures these classes completely into a vibrant, hands-on learning environment through the use of Internet image and data products, geographical information system

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software, and simulation products. A World Wide Web home page that contains selected data and training modules is being designed specifically for the meteorology and geology laboratory. Following one year of construction, student operation, and student evaluation, the home page will be made public to the entire environmental studies community.

This project prepares science majors with effective computational analysis skills they can use in their respective areas of specific interest. For non-majors, exposure to this technology may encourage them to pursue higher-level science and mathematics courses. This laboratory is of particular importance for future primary and secondary educators, as these courses may represent their only exposure to meteorological and geological technology.

An Integrated and Networked Microscopy Center for Undergraduate Education

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DUE-9650654
\$99,994
Life Sciences

This project concentrates on the formation of an Integrated Microscopy Facility (IMF) in the biology department. The IMF supports laboratory exercises at all levels in the curriculum (freshman to graduate); the exercises are experimental in nature and can foster analytical thinking skills through students' collaborative analysis of data. Some of these students will graduate to become teachers. Southwest Texas State University produces more than 2,000 elementary and secondary school teachers each year, including 30-35 certified to teach biology. In addition, an outreach program with area high schools is being established.

A laser scanning confocal microscope (LSCM) is being added to the existing transmission electron and light microscopes to form a state-of-the-art microscopy facility. This increases the networking capabilities of the facility and enables computer-controlled imaging and display. Digitization of images permits each student to collect images from their specimens and later retrieve the images using a computer at a site remote from the IMF. Widespread use of the IMF is possible because the LSCM includes a UNIX-based computer that can be fully networked. Networking with hardware already in place permits images from the IMF to be accessed from all over campus and from all over the world. Thus any teaching laboratory with a workstation (consisting of any modern PC or Mac) can access the IMF. Accessible images include those from all the microscopes in the IMF, as the LSCM computer can also be used to acquire and store images from these sources.

The IMF allows students access to high technology in a familiar, computer environment. The LSCM provides technology that makes remote access to image files by students possible. Implementation of the objectives of this project markedly increase the level of science education in biology and provide a model program for other universities to emulate.

A Mobile Multimedia Computer Laboratory Mentorship Approach to Improving Undergraduate Mathematics Education

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DUE-9650656
\$69,900
Mathematics

This project is assembling a completely mobile, state-of-the-art multimedia laptop computer laboratory, networked through wireless infrared technology. The laboratory is being used for undergraduate mathematics courses for majors, client disciplines, and pre-service teachers. This portable laboratory represents an extremely versatile configuration that enables any classroom to be used as a normal classroom, as a technology demonstration room, and as a computer laboratory.

The ACE Teaching Cycle forms the unifying theme for the different content areas using the mobile computer laboratory. This pedagogical approach implements the findings of current constructivist learning theory research by providing students with an experiential base with mathematical ideas through carefully constructed computer activities in cooperative learning groups before formal discussion of the material. During the first phase, each of the co-PI's fully implements activity-first mathematics courses using the mobile computer laboratory. Two of the five courses targeted during this phase are directed at elementary and secondary school pre-service teachers. Other courses include *Calculus II*, *Introduction to Statistics*, and *Business Calculus*. The second phase involves doctoral candidates teaching undergraduate courses using the mobile computer laboratory under the supervision of the co-PI's. These interns in the mathematics doctoral program, with concentration in the teaching of college mathematics, can concurrently be involved in their second research-based course in the teaching of college mathematics. The final phase involves an increased number of undergraduate courses throughout the undergraduate mathematics curriculum using the laboratory with additional graduate faculty members mentoring interns in teaching college mathematics.

Development of a Process-Driven, Research-Oriented Field Environmental Program with Modern Sampling and Analysis Equipment

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DUE-9650702
\$30,000
Life Sciences

This project produces scientifically-literate, environmentally-aware citizens among non-science majors, and competitively-educated, critically-thinking environmental biology majors. The focus is a watershed-stream complex integral to the campus. The scientific method is experienced by students through hands-on data acquisition, analyses and interpretations in assigned class-cooperative research projects. To educate students in policy processes, multiple classes coordinate data to produce an environmental impact assessment at least once a year. The project also emphasizes the importance of data quality objectives, sampling protocols, precision in the field, documentation, and adequate databases from which the students can draw conclusions. Underrepresented groups in science are addressed, and a strong component involves field practicum experiences for individuals pursuing a teaching career with an emphasis in environmental studies.

Improving Mathematics Instruction Using Computers and Calculators

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DUE-9650743
\$44,149
Mathematics

This project is integrating the use of technology into mathematics classes to support reform in both content and pedagogy. The three areas in which the reform is being carried out are College Algebra, the Calculus Sequence, and a Mathematics Seminar for Prospective Secondary School Teachers. Improvements being made in the three classes include: 1) integration of calculator and computer activities into the classes; 2) addition of laboratory activities to encourage active student participation; 3) an emphasis on realistic applications; 4) addition of group projects; and 5) certain curriculum revisions. These improvements are being phased in over a two year period.

Modern Life Science Experiments for Tomorrow's Teachers

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DUE-9650766
\$17,844
Life Sciences

This institution, a small, historically black, four-year institution is enhancing its biology laboratories. Although the State of Missouri approved an expanded mission and additional degree programs in 1993, years of underfunding have left the college lacking the equipment necessary for effective undergraduate teaching. This is particularly true of the laboratory experience. The addition of an approved biology specialization area in the new secondary education program has meant that, while enrollment in upper-level biology laboratory courses has increased, the college has been unable to provide students with the hands-on laboratory experiences essential to pre-service teachers. The conceptual foundation and thorough understanding gained through advanced laboratory experiments greatly enhances the entering teachers' ability to teach secondary-school science. The use of current technology in molecular biology and biotechnology, including differential centrifugation, ultraviolet spectrophotometric DNA analysis, and gel electrophoresis not a "luxury" but a necessary practice.

The pre-service teacher has a particularly important role in the education of underrepresented groups. With a student enrollment that is 75% African American, this college has a long record of service to the non-traditional, first-generation college student from an economically disadvantaged background. Most participants are minority women and, upon graduation, are likely to teach in predominantly minority, urban schools, such as in the City of St. Louis. The long-range impact may be that a new generation of well-prepared teachers are making their own students ready for the challenges of the 21st century.

Using Diverse Multimedia Strategies to Promote Meaningful Learning in Physics, Geology, and Biology for Prospective Elementary Teachers

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DUE-9650829
\$45,930
Interdisciplinary

At San Diego State University, about 450 pre-service elementary teachers each year take one or more specially designed undergraduate courses in either physics, geology or biology. These courses incorporate extensive class discussion, hands-on experimentation, collaborative learning and the creative use of computers. The computer equipment obtained with NSF support is enabling course instructors to develop and integrate more advanced multimedia projects to enhance the science learning experiences of the students in many new and exciting ways. The physics course is using the new computers with powerful new software developed on another project to help students construct conceptual models in various domains of physics. This new software provides tools for knowledge construction and simulations of physics phenomena. Students working in groups build physics understanding by using idea containers, electronic journals, bulletin boards and World Wide Web resources to promote meaningful conversations as part of learning. They make predictions about the outcomes of experiments and test their predictions against actual apparatus as well as computer simulations. The geology course is furthering integration of hands-on collaborative learning with multimedia and World Wide Web resources through enhancement and further development of the World Wide Web page called TREES (Teaching Resources for Education in Earth Science). CD-ROMs are being used to explore earth science, and student field experiences are being used to create virtual field trips that are available on the Web. The biology course is promoting meaningful learning by engaging students in using their experiential knowledge to construct semantic networks. Using new multimedia tools and the latest version of the software SemNet, students are able to build networks that incorporate images, QuickTime movies and Web resources all stored on compact disk and made available on the Web. Results of development efforts in all three courses are being disseminated widely through many channels, including Web pages, other teacher enhancement projects, and professional meetings and publications. A particular effort will be made to share resources with other faculty in the California State University system, which produces nearly 3,000 future K-6 teachers every year.

Enhancing Student Chemistry Learning by Changing Instruction and Assessment Practices

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DUE-9651124
\$40,831
Chemistry

A computer laboratory is being developed for interactive pre- and post-chemistry laboratory assessment and instruction of students in general and organic chemistry, and to provide computer laboratory teaching experiences for pre-service high school chemistry teachers. The computer laboratory enables teachers to reinforce learning by showing students how "wet" laboratory experiences can be integrated with lecture ideas in terms of concepts being covered and laboratory skills being practiced. Quicktime movies allow presentation of, and questioning about, reactions that are too dangerous to have students

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perform in the laboratory. Students view, and are tested on, Quicktime video clips about the safe use of laboratory equipment. For pre-laboratory instruction, the computer environment provides an opportunity for students to take part in interactive questioning to determine whether they have the knowledge needed to successfully complete the laboratory.

The “wet” laboratory environment is an important part of chemistry that is not to be replaced by computer facilities. Students are using calculator interfaced laboratory methods of acquiring and analyzing data from “wet” laboratory experiments as a part of this project. The post-laboratory computer laboratory can be a place for students to be assessed on their learning of the laboratory material, to extend their learning, and to be guided by further work if deficiencies are revealed. The facility also provides pre-service teachers an avenue for developing and using instructional and assessment materials to facilitate chemistry learning. The two-year implementation period includes both formative and summative evaluations that enhance instruction and quizzing practices used in the project. Materials from the project are being made available to others through computers (World Wide Web), workshops, and print resources.

Portable Computer Algebra System Laboratories

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DUE-9651142
\$61,218
Mathematics

A Kentucky consortium comprised of six colleges in the University of Kentucky Community College System, Northern Kentucky University and Morehead State University is joined by two colleges in Florida and Georgia to adapt ongoing graphics calculator and computer algebra system projects for use with the new TI-92 and CBL (Calculator-Based Laboratory). The project begins with a workshop at Northern Kentucky University (funded previously) and adapts extant CBL/TI-82/CAS activities to the new hand-held system. The project focuses on calculus instruction, with extensions to individual precalculus, physics, engineering technology, and teacher training courses at various colleges. The project can give the consortium members a “jump start” on exploring appropriate use of the hand-held CAS capabilities in the curriculum.

Instrumentation for Interdisciplinary Open Laboratories

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DUE-9651167
\$94,817
Interdisciplinary

This project addresses the acquisition of equipment for project-oriented open-schedule laboratories and learning support facilities for interdisciplinary science courses. The institution now offers three interdisciplinary science courses for education majors and an interdisciplinary core science sequence of two courses that is being developed under a current National Science Foundation grant. The new equipment is being used in conjunction with these five courses. Experience gained in these laboratories can ultimately be used as a basis for the development of laboratories and learning support facilities that will be used by all

education majors and by all students taking core science courses. This project deals with a number of common problems in undergraduate laboratory science, including the efficient use of space, equipment, and personnel; the difficulties of applying active learning techniques under the constraints imposed by large class sizes; and the need to improve science literacy and process skills to national levels.

Workshop Interdisciplinary Mathematics and Science Course

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DUE-9651294
\$26,663
Interdisciplinary

Many students in the general education science and mathematics courses understand little about how science is done or about the major themes and concepts of science and mathematics. This project addresses these problems by developing a hands-on, laboratory-based, integrated mathematics and science general education course. The course is designed for all students who are not majoring in science or mathematics and is especially appropriate for pre-service teachers.

The course is a team-taught, two-semester sequence that meets five hours per week in a workshop format combining lecture, hands-on activities and exercises, and laboratory. Each semester is 4 credit hours. The objectives of the course are to emphasize relationships among the scientific disciplines, to coordinate mathematics with science, to promote science literacy, and to enhance the understanding of science by teaching it as it is practiced. The course is truly interdisciplinary in nature, examining both unifying themes in the sciences and the contributions of mathematics to our understanding of the natural world. The course also examines science from historical, philosophical, and contemporary social perspectives. Toward these goals, the course engages students as active participants in learning through open-ended investigative laboratory experiences, group projects both in the laboratory and the library, and the presentation of ideas in oral and written form.

Students completing the course are expected to have improved their critical thinking skills and be better able to navigate in the scientific and technological world. The course is also expected to prepare the pre-service teachers in its audience to convey the nature and content of science and mathematics better in their own classrooms.

Computer Laboratory on Wheels

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DUE-9651367
\$42,440
Mathematics

This project addresses two major needs. First, while the university's computing power is high and maintained by an excellent academic computing staff, use of computers for mathematics instruction has been limited to calculus and the *Computers in Elementary/Middle School Mathematics* course. Second, a *Concepts of Calculus* course for prospective middle school teachers has not been taught at the university since 1985. This project addresses these needs with the purchase of 24 IBM notebook computers, a wheeled

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rack to store and transport the computers, and appropriate software. This computer laboratory on wheels can be wheeled to any classroom in the building. An "access point" mounted on the rack allows the notebook computers to communicate, by wireless connection, with the campus network, as the access point is plugged into a LAN wall outlet. The computer laboratory on wheels serves two purposes: 1) to create widespread (but not necessarily intensive) use of computer technology for classroom instruction; and 2) to be used extensively in the *Concepts of Calculus* course.

Furthermore, to provide "bench lab/hands-on" experiences in the *Concepts of Calculus* course, this project involves purchase of Lego™ Data Technology Building Sets and Control Labs. This equipment enables students to build working models with wheels, gears, and motors that can be controlled by a computer. Data acquisition devices on the models send information to the computer for analysis. The rack of computers is being housed in the department's Mathematics Education Resource Office, where faculty members may check it out for classroom use and students may check out computers for use in the office when the rack is not being used elsewhere. The paradigm of a shared computer laboratory on wheels may be an attractive solution for many other universities and public schools.

Integrating Group Laboratory Activities Across the Chemistry Curriculum

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DUE-9651050
\$37,168
Chemistry

An initiative entitled *Integrating Group Laboratory Activities Across the Chemistry Curriculum* is working to solve a serious problem in chemistry education: non-science and science majors enrolled in introductory courses are not involved in cooperative group laboratory exercises relevant to the environment, advanced materials, and biotechnology because of the lack of versatile, state-of-the-art instrumentation.

As a group project in instrumental analysis, chemistry majors are developing and testing protocols involving CE, IC, infrared, and VIS spectroscopy. These experiments are being exported to introductory chemistry laboratory courses and executed by combined groups of science and non-science majors. Chemistry majors, acting as peer-instructors, guide students in executing experiments that reinforce chemical concepts. The project supports three major objectives in a revised introductory chemistry curriculum: cooperative laboratory interaction between students in *General Chemistry*, *The Chemical World Around Us*, and *Instrumental Analysis*; rigorous demonstration of quantitative chemical principles in relevant contexts to modern chemical perspectives; and a challenging project-oriented laboratory experience that facilitates peer-directed group learning. The audience for this project includes women of traditional college age who are enrolled in introductory chemistry courses, as well as junior and senior chemistry majors. About 45% of the students in the *Chemical World* course are pre-service teachers.

The project affects more than 300 students. The impact of this project is that it increases interaction between students in the upper- and lower-division courses, introduces women to technology-centered experiments, introduces pre-service teachers to pedagogy that will be important to them in their future classrooms, introduces sophisticated concepts in the context of modern chemical experiments using instrumentation, and creates peer-directed learning opportunities for science and non-science majors.

UNDERGRADUATE FACULTY ENHANCEMENT (UFE) PROGRAM

Maryland Undergraduate Mathematics Enhancement Program II (MUMEP II)

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DUE-9554632
\$98,505
Mathematics

The Maryland Undergraduate Mathematics Enhancement Program II (MUMEP II) is a coalition of community college, four-year college, and university undergraduate mathematics teaching faculty in the general region of Maryland, the District of Columbia, and Virginia, organized around a two-year faculty enhancement program for 32 participants during each of the years 1996 and 1997. In July 1996 a one-week workshop will explore "Visual Thinking in Chaotic Dynamics" and in July 1997 a one-week workshop will explore "Visual Thinking in Fractal Geometry." A pair of day-long follow-up seminars will take place during the academic year following each workshop. The primary goals of MUMEP II are: 1) to present new visual mathematical topics to faculty from institutions in the region and to use graphics calculators and computer graphics to enhance understanding of the new visual mathematical topics; 2) to relate the new visual mathematics topics to existing undergraduate mathematics courses wherever reasonable; and 3) to promote communication and collaboration among faculty in the area's institutions. In addition, special teacher preparation activities are planned to engage faculty who teach significant numbers of pre-service teachers. In particular, the project's recruiting efforts will look for opportunities to involve such faculty, and workshop activities will showcase lessons that can be incorporated in mathematics classes taken by prospective teachers and in school mathematics classes as well. All materials prepared for or during a workshop or seminar will be disseminated during the session or shortly thereafter. Under the guidance of members of an Advisory Board, evaluation of the program will be facilitated through daily and summary questionnaires.

Undergraduate Faculty Enhancement in Mathematics

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DUE-9554651
\$80,000
Mathematics

The teaching of undergraduate mathematics courses for future school teachers is being enriched by week-long summer workshops for college and university faculty in which they will: 1) experience new teaching strategies and techniques; 2) experience examples of non-test based assessment schemes; 3) learn about and observe these and other examples of pedagogical techniques that have been successful in encouraging women and underrepresented minorities to excel in mathematics; 4) learn new subject matter and experience new instructional materials being produced by the Cornell Undergraduate Geometry Project which relate both modern and rarely studied geometry topics with the mathematics subject matter of the middle and high schools; 5) have the opportunity to interact and share with colleagues and experts who have common interests in the teaching of mathematics to future school teachers, and to develop plans to incorporate both teaching techniques and new curricular materials into their own courses; 6) learn about

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and share ideas concerning the recent recommendations, guidelines and standards put forth by the Mathematical Sciences Education Board (MSEB), the National Council of Teachers of Mathematics (NCTM), and in publications of the Mathematical Association of America (MAA) concerning changes in the teaching of undergraduate mathematics; and 7) be committed to participate after the workshop in several of the planned follow-up activities.

Undergraduate Faculty Enhancement in Elementary Pre-Service Mathematics Education for Two-Year Colleges

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DUE-9554663
\$74,990
Mathematics

Faculty at the University of Southern Mississippi are conducting a series of workshops with mathematics faculty from two-year colleges who teach pre-service teachers. Coordination between faculty at two- and four-year institutions is critical, as an increasing number of students in pre-service teacher preparation programs at the university level transfer from two-year schools. The workshops will provide access to experiences with current approaches to mathematics content and pedagogical activities called for by the NCTM Standards. This project will provide participants with the material and support necessary to successfully incorporate the workshop topics into their present curricula, and to develop the capability of all participants to serve as leaders in their home institutions. Furthermore, participants will share their approaches to incorporating project topics into the curricula through publications and presentations at professional meetings.

Molecular Genetic Analysis Applied to Evolution, Ecology, and Systemic Biology: An Extended Laboratory Course

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DUE-9554685
\$207,065
Life Sciences

Undergraduate Faculty Enhancement project at San Francisco State University will provide for each of the next two years, an intense twelve-day laboratory short course in *Molecular Genetics & Evolutionary Biology* in the summer with a four-day follow-up session each January and on-going technical and material support. A highly successful established format that evolved from 10 prior national Chautauqua courses was used in the design and development of our proposed Undergraduate Faculty Enhancement project. Twenty-two faculty will be selected each year from a national applicant pool comprised of faculty from community colleges, four-year liberal arts colleges and universities, comprehensive universities, and research universities. Participants will learn the fundamentals of molecular biology through the presentation of lectures and demonstrations, and they will also conduct a series of experiments to develop skill in PCR amplification, restriction enzyme analysis, and various gel separation techniques. In research groups of 4-5 composed of a mix of faculty from community colleges and four-year institutions, the participants will investigate "thematic" research projects. Seminar speakers will discuss their research on prokaryote, vertebrate, invertebrate, and plant systems, and their application of molecular techniques. Faculty will

implement the molecular techniques that they learn by adapting the exercises from the course into undergraduate laboratory courses at their respective institutions. Trained faculty will have gained the extraordinary capabilities afforded by these techniques to access the genomes of natural populations from any taxon on earth and thus create unique laboratory curricula at their own institutions. The SFSU faculty and instructional support technicians will support participants after the summer course in the incorporation of molecular techniques and analysis in undergraduate instruction. The workshop will be used to develop laboratory modules and exercises for use in primary and secondary education, however, participants will also develop skill and confidence with molecular techniques to use in their research.

Faculty Advancement In Mathematics (FAIM)

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DUE-9554736

\$133,314

Mathematics

Mathematics is undergoing remarkable advances. The scope of mathematical applications is broadening into new disciplines and reaching a more diverse student population. Courses and other educational experiences for prospective mathematics teachers at all levels provide an important lever that will help bring about this revolution in the undergraduate curriculum. Just as many current college faculty are not in a position to infuse contemporary mathematics and its applications into their teaching, many undergraduates who are currently preparing to teach at the elementary and secondary levels are also not sufficiently aware of important current mathematics. It is important that the presence of contemporary applications of mathematics be increased in the undergraduate preparation of those who will teach at all levels. To address this opportunity and challenge, workshops are scheduled for the summer of 1996 and 1997. The workshops will be of two-weeks' duration, with 25 participants per workshop. The 1996 workshops will be held at Virginia Commonwealth University and the United States Military Academy. The focus of each workshop will be contemporary applications of mathematics in the broadly defined areas of mathematical modeling, discrete mathematics, and geometry. They will feature mathematical topics of increasing emphasis and importance.

SPECIAL PROJECTS

Assessing and Certifying the Practice of Highly Accomplished Science Teachers

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ESIE-9553567

\$500,000

Through this project, the National Board for Professional Teaching Standards (NBPTS) will conduct the necessary research and development to build a fair and trustworthy assessment process for its Adolescence and Young Adulthood (ages 14-18+) Science certificate. This will mark the first effort to

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extend the opportunity for National Board Certification to the nation's science teachers. Subsequently, NBPTS plans to take advantage of the findings of this project in constructing assessments for its Early Adolescence (ages 11-15) and Middle Childhood (ages 7-12) Science certificates.

A two-part assessment is envisioned. The first part involves candidates for National Board Certification in preparing a portfolio of their practice during the course of a school year. The portfolio includes videos of their practice, samples of student work and commentaries on the rationale of their instructional approach and its effects. The second part takes the form of a one- or two-day assessment center candidates attend in the summer, during which they proceed through a series of exercises focused on issues teachers in their field regularly encounter. The challenge is to build an assessment process that is reliable, fair, and valid as it measures the critical aspects of teaching that distinguish the practice of highly accomplished Adolescence and Young Adulthood Science teachers as captured in the Standards NBPTS has developed for this field. Investigators must find a way to balance the following often competing objectives – administrative feasibility, professional acceptability, public credibility, legal defensibility and economic affordability.

The project will be conducted over a three year period during which a systematic series of pilot tests will be conducted, scoring rubrics developed and procedures invented for administration of the assessment center exercises and training of examiners. The pilot tests will involve diverse groups of teachers from across the nation. The project will conclude with a series of analyses following the first full administration of the assessment package that will take place during the 1997-98 school year. The assessment methodologies being explored by this project are designed to advance the state-of-the-art in teacher performance assessment. The results should inform the work of policy makers, teachers, administrators and scholars with an interest in teacher preparation and continuing professional development, teacher licensing, teacher evaluation and the organization and management of schools. National Board Certification is designed to recognize and reward excellence in teaching, redefine teaching as a career, serve as a robust model of professional development, and foster practice that can yield a future with promise for all America's children.

Invitational Forum on Teacher Preparation for Deans of Science and Education

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DUE-9622600
\$74,989

An invitational "Forum on Teacher Preparation for Deans of Science and of Education" was conducted by the American Association for the Advancement of Science from February 21-23, 1996. Fifty institutional teams (each composed of a dean of education and a dean of science from major research universities and comprehensive universities with large teacher preparation programs) attended the meeting to consider ways in which collaborations among their academic divisions and school personnel can better prepare future teachers of K-12 science and mathematics. The purposes of the Forum are: 1) to present a summary of the research results on the teaching and learning of science and mathematics; 2) to consider exemplary teacher preparation programs that model collaboration among university science and education departments and local schools or school districts; 3) to engage the deans in discussion of the issues associated with the

design and implementation of such exemplary programs; and 4) to inform the deans of opportunities, such as the National Science Foundation's Collaboratives for Excellence in Teacher Preparation program, to engage in large-scale systemic projects designed to change significantly teacher preparation programs, on a state or regional basis, which will serve as comprehensive national models. Participants will receive background information prior to the meeting. Based upon discussions and models presented at the Forum, a workbook, including recommendations for collaborations and the components of model teacher preparation programs, will be produced and made available to participants and others interested in improving teacher preparation.

Conference on State Strategies for Improving Teacher Preparation and Certification Consistent with Science Education Standards

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DUE-9624744
\$63,706

A national conference is being held to focus attention of state education leaders on the implications of the recently released National Research Council (NRC) Science Education Standards and other national and state Standards for K-12 science content for the preparation of science teachers. Three important factors inform the preparation of science teachers: 1) state policies; 2) teacher preparation programs designed by schools of education; and 3) undergraduate science curricula. Leaders from each of these areas will be speakers and/or panelists in several plenary sessions. Conference participants will be state education and science leaders who will attend as teams to facilitate: 1) discussion of the need for improving science teacher preparation in light of the new standards; 2) consideration of various models and approaches toward improvement; and 3) initiation of intra-state strategies for coordinated reform of policies and programs of science teacher education.

SUPPLEMENTS AND CONTINUATIONS

Teacher Preparation and Enhancement Workshop for the CSU-Alliance for Minority Participation

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HRD-9353276
\$10,000

A workshop for K-12 teachers will be held at the annual meeting of the Society for Advancement for Chicanos and Native Americans in Science (SACNAS). The workshop will be based on the concept of providing open-ended, hands-on experiences for teachers using examples derived mostly from Native American cultures. The workshop team consists of: 1) a professor, who will serve as a resource for these teachers when they later use this information in their own classrooms; 2) master teachers who will provide the pedagogical expertise so that teachers may use this information at an appropriate grade and developmental level; and 3) those new teachers who will implement the workshop at their school with the assistance of the master teacher and the professor. Undergraduate and graduate students who are interested in teaching will be actively involved in preparing for the workshop, and will attend and assist at the workshop. The teachers will assess the value of the team approach and of the workshop after they have had six months to use the information in their classrooms.

Reforming the Preparation and Professional Development of Elementary and Middle School Mathematics Teachers

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ESIE-9354104
\$751,309
Mathematics

This project is producing mathematics content course modules for use in teacher preparation and teacher enhancement for elementary and middle school teachers of mathematics. Modules address: number sense with whole and rational numbers, proportional reasoning, measuring, spatial sense and geometry, exploring data, chance, patterns and functions, and mathematical change. The materials developed provide course instructors the opportunity to model the types of instructional delivery expected of teachers in grades K-8, both in their classroom and through the inclusion of videos of student interviews and classroom episodes from grade K-8 situations. Modules will be available nationwide upon completion. The modules will be in software and CD-ROM format giving each instructor the capability to modify the material to meet their individual needs.

A New Model for Physics Education in Physics Departments: Improving the Teaching of Physics from Elementary through Graduate School

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DUE-9354501
\$2,315,530
Physics

A comprehensive, multifaceted program is being developed by the Physics Education Group in the Physics Department at the University of Washington. The program consists of a group of interrelated projects that focus on undergraduate course improvement, teacher preparation and enhancement, and university faculty development. The goals for the project are: 1) to expand the knowledge base of how students learn physics; 2) to increase student learning in the introductory physics course; 3) to prepare K-12 pre-service and in-service teachers to teach science as a process of inquiry; and 4) to improve the teaching effectiveness of present and future college and university faculty. Ongoing investigation of student understanding in physics guides the development of instructional materials for introductory physics students and for pre-service and in-service teachers. The project is conducting workshops for undergraduate faculty, and inviting faculty interns for short-term visits to observe the project activities first-hand. In addition, a Faculty Development Handbook is being produced to help prepare teaching assistants, postdoctoral research associates, and junior faculty for their role as physics instructors.

Interactive Mathematics Teacher Preparation Project

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DUE-9354776
\$368,029
Mathematics

This proposal articulates the development of a new undergraduate mathematics education program consisting of three new courses for undergraduate pre-service secondary mathematics teachers and two new courses in developmental entry level mathematics based on a proven secondary reform curriculum. The developmental courses are adaptations of the highly acclaimed reform secondary mathematics curriculum, the Interactive Mathematics Project (IMP). The pre-service courses provide training in the philosophies, attitudes, objectives, and methods underlying the new reform curriculum and include specific training in the delivery of the adapted IMP materials. The pre-service teachers participate in a highly structured field experience based on reform ideas as they actually teach (under the supervision of mathematics education faculty) the two new developmental courses to college students with entry level mathematics deficiencies. The project is conducted in two distinct settings: CSU, Chico (a typical four year institution that has remedial students and a teacher preparation program) and in a collaborative setting between the University of California, Santa Barbara (a research institution with pre-service teachers) and Santa Barbara City College. Development of the curriculum, materials, and implementation design allows easy export to other higher educational settings throughout the nation. This innovative pre-service-developmental proposal provides both an important advancement in aligning secondary mathematics teacher preparation programs with reform ideas and an economical solution to the growing bottleneck of students with entry level mathematics problems.

The Development of Proof Understanding, Production, and Appreciation (PUPA) with Undergraduate Mathematics Majors

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REC-9355861
\$149,058
Mathematics

The project has the potential to break new empirical and theoretical ground and further the understanding of what it means to understand mathematical proof and how that understanding develops. The knowledge gained from this study has the potential to impact significantly the way pre-service teachers develop their own abilities to teach proof and ultimately how mathematics and mathematical proofs will be taught and learned in school and college settings.

Institute in the History of Mathematics and Its Use in Teaching

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DUE-9455088
\$428,761
Mathematics

The Mathematical Association of America (MAA), in cooperation with The American University, has created an Institute in the History of Mathematics and its Use in Teaching (IHMT). The goal of the Institute is to encourage the incorporation of history into the undergraduate mathematics curriculum at all levels. Special attention is focused on including the history of mathematics in teacher preparation programs, as called for in the NCTM Standards. Through intensive three-week programs in two successive summers, 80 mathematics faculty members are being prepared to teach special courses in the history of mathematics, as well as to use history to improve their teaching of courses in the standard mathematics curriculum. Thirteen historians of mathematics lead explorations of the history of mathematics from antiquity through the twentieth-century, stressing applications and links between different areas of mathematics. Specific techniques for incorporating history into undergraduate mathematics courses are a central theme. The information and techniques of IHMT are being disseminated nationally through presentations at national and regional mathematics meetings, publications, and electronic communications. The home institutions of the participants, the students at these institutions, and the collegiate mathematics community will benefit from this broader understanding of mathematics and its teaching. Through the inclusion of history in the undergraduate mathematics curriculum, a new generation of teachers will be able to enrich the courses they teach and benefit all students, at all grade levels, with interesting and relevant courses in mathematics.

A New Model for Introductory Biology at Two-Year and Community Colleges

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DUE-9455725
\$1,320,000
Life Sciences

In recognition of the importance of introductory biology courses at two-year and community colleges to the development of scientific literacy among college-educated individuals, BSCS is conceptualizing, writing, testing, and evaluating a set of innovative curriculum materials for biology students at the college level. Collaborating in the 36-month project are fifteen partners: biology faculty at eight community colleges (including several that offer programs in biotechnology and environmental technology); the American Association of Community and Junior Colleges (AACJC); the two-year college section of the National Association of Biology Teachers (NABT); the Society for College Science Teaching (SCST), the American Mathematical Association of Two-Year Colleges (AMATYC), the American Institute of Biological Sciences (AIBS), Ward's Natural Science Establishment, Inc., and Kendall-Hunt Publishing Company (college division). The completed program will offer an integrated and coherent approach to helping students achieve three major goals of biological literacy: 1) to understand the basic unifying principles of biology; 2) to develop the fundamental skills of critical thinking and scientific reasoning; and 3) to recognize the applications of science, especially relationships among science, technology, and society. The project will impact future teachers of science at the elementary and secondary levels. Students are encouraged to reflect on the overall design of the program, the strategies that help them learn, and the efficacy of the various teaching techniques and assessment practices employed in the course. Project products include student materials (readings, activities, and laboratory exercises) supporting both semester- and year-long introductory biology courses. The materials include an instructor's guide with extensive background reading and specific implementation support; use of a hands-on, open-ended inquiry, collaborative approach to learning; and emphasize the relationships among science, technology, and society. The project includes faculty development workshops (based on a model designed and tested by the partner faculty) that will be supported after the end of the project by revenues realized from sales of project materials.

***ChemLinks* Coalition: Making Chemical Connections**

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DUE-9455918
\$2,715,000

The *ChemLinks* Coalition is undertaking a five-year project to change the way students learn chemistry, increase scientific literacy for all students taking chemistry, and promote the process of educational reform. Collaboration among faculty from different disciplines and a number of institutions supports and reinforces those who want to make changes. The coalition consists of leading liberal arts colleges (Beloit, Carleton, Colorado, Grinnell, Hope, Kalamazoo, Knox, Lawrence, Macalester, Rhodes, Spelman, St. Olaf, Wooster) and research universities (Chicago, Washington - St. Louis) which already have experience working together on chemistry curricular reform. In collaboration with the *ModularChem* Consortium, faculty are

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developing, testing, and disseminating modular course materials, focused on the first two years of the chemistry curriculum, that use active and collaborative approaches to learning. These materials start from interdisciplinary themes important to students and to society (e.g., the molecular basis of life, the environment, technology), and are designed to develop an appreciation of how science is actually done. This approach is designed to reach a broader student audience more effectively than do traditional courses; an audience that includes students who are members of groups traditionally under-represented in science, non-science majors and those taking chemistry as a supporting course, as well as chemistry majors. By providing a model for students preparing for careers in teaching, this approach has an impact on Teacher Preparation programs. In addition, an alliance with the Advanced Technology Environmental Education Center's coalition of two-year institutions assures an impact on Advanced Technological Education Programs. By using the extensive Project Kaleidoscope network to promote reform, the *ChemLinks* Coalition involves a large and diverse group of institutions in making systemic and sustainable changes in undergraduate chemistry education.

A Workshop Chemistry Curriculum

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DUE-9455920
\$1,525,000

The City College Consortium, which includes ten senior and community colleges at the City University of New York, and the Universities of Pittsburgh, Pennsylvania, and Rochester, is developing and applying widely a new model of teaching chemistry. This model, called *Workshop Chemistry*, introduces participation and mentorship by recent graduates of the course. Each week two, hour-long student-led workshops complement the lecture and laboratory components, by providing a collaborative learning experience that increases student involvement and supports a new role for students as mentors. In *Workshop Chemistry*, students learn the problem solving, communication, and teamwork skills crucial for success in the workplace while learning chemistry more effectively. Working together with the faculty, students become an active part of the community of the department. A prototype workshop model has been developed at City College in a general chemistry course for science and engineering majors, and is being expanded and refined for a broad range of courses including preparatory chemistry, chemistry for allied health sciences, organic chemistry, instrumental, and analytical chemistry. The experience of students as workshop leaders provides a natural introduction to teaching that is being formalized through a Teacher Preparation component of the project. The workshop method is also being exploited and applied in curricula for technician training, an initiative relevant to Advanced Technological Education. The project evaluates the *Workshop Chemistry* approach and disseminates it beyond the bounds of the consortium. Student Manuals that include the problem solving, model building, and simulation activities of the workshops are being produced for each course.

Sweeping Change in Manageable Units: A Modular Approach for Chemistry Curriculum Reform

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DUE-9455924
\$2,865,000

The purpose of this program is to develop new curricula, materials, and teaching methods which will enhance the appreciation and learning of science, especially chemistry, for every undergraduate student. To this end, a modular approach to teaching chemistry in the first two years of the undergraduate curriculum is being developed and evaluated. Modules of one to four weeks present fundamental chemistry to students in the context of a real-world problem or application and emphasize the links between chemistry and other disciplines. In collaboration with the *ChemLinks* Coalition, modules are being developed, tested and refined at the two- and four-year colleges and research universities comprising the two consortia. Curriculum materials, including text, laboratory manuals, and multimedia components suitable for students from diverse cultural and ethnic backgrounds and usable at a wide variety of undergraduate institutions are being produced and distributed by an established publisher. Teaching methods which utilize current understanding of learning processes and emphasize active learning and the full spectrum of modern technologies are being supported, tested and promulgated. A framework for continuous improvement of curricula resulting from the work will be institutionalized within the consortium. Faculty workshops and sessions at national and regional meetings will be conducted to guarantee dissemination. Since the consortium institutions participate significantly in pre-service teacher preparation and the education of advanced science or engineering technicians, special modular materials appropriate to the task of educating future teachers and technicians will be developed.

Establishing New Traditions: Revitalizing the Curriculum

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DUE-9455928
\$3,749,591

This project establishes new traditions in the chemistry curriculum that optimize opportunities for all students to learn chemical facts and concepts, develop and pursue interests in chemistry and chemistry-related disciplines, and appreciate how an understanding of chemistry is important to life and living. Project materials and methods are intended to change fundamentally the ways students, faculty, and administrators view their roles, creating a student-centered, active-learning emphasis. Five main areas are addressed: student-focused active learning; inquiry-based/open-ended laboratories; interdisciplinary course clusters to create learning communities; a topic-oriented curriculum; and information technology/computer tools. Each development in each area is carefully evaluated, and only the best survive. Evaluation provides important information about the process of transfer of innovations among institutions of different types. To insure that reforms are useful for all students, the consortium includes industry, public and private four-year institutions, minority institutions, and two-year colleges. The project gives special emphasis to students who choose teaching as a career by main-streaming these students in courses which benefit them in both content and pedagogy. Students, including those in Science Education, are fully integrated in the

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development and implementation of the project, working on both research topics and evaluation. The project also gives special emphasis to community college students in Advanced Technological Education programs to ensure that they benefit from the newly developed curricula.

Mathematics Across the Curriculum

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DUE 9552462

\$4,000,000

This project integrates the study of mathematics with courses in physics, chemistry, geology, biology, social science, economics, art, music, philosophy, computer science, architecture, medicine, engineering, and literature. Faculty representing these disciplines at a large number of institutions are cooperating with faculty from Dartmouth to develop course materials for use in a variety of ways: in conjunction with other texts; as independent reference materials; and as bases for new interdisciplinary courses. Support materials for faculty, including documented software, on-line materials, and videotapes, are being developed. The project is expected to result in fundamental changes at the institutions in the project. In addition, through the materials being developed and a series of intensive summer workshops, the project will benefit faculty and institutions other than those directly involved in the project. The project will impact students in both upper and lower division courses, students taking courses in their majors as well as students taking courses as part of their general education, and students preparing to be teachers. Some materials, as appropriate, will be adapted for use at the secondary level.

Middle Atlantic Consortium for Mathematics and its Applications Throughout the Curriculum

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DUE-9552464

\$2,196,693

This project promotes a climate in which faculty from all disciplines view themselves as being jointly responsible for the scientific, mathematical, and technical education of undergraduates. A consortium comprised of the University of Pennsylvania, Villanova University, Polytechnic University, Community College of Philadelphia, two Philadelphia public schools, and the Society for Industrial and Applied Mathematics (SIAM) is undertaking a major initiative to integrate research and real-world applications from various disciplines into the mathematics curriculum, and to achieve more effective integration of advanced mathematics and computing into the curricula of disciplines that use mathematics. The project has four major components: 1) the creation of application modules for mathematics courses and mathematics modules for other-discipline courses; 2) the development of basic and advanced interdisciplinary courses that integrate mathematics with specific application areas; 3) the development of applications and laboratory-oriented courses for mathematics majors; and 4) the development of materials for students in courses such as business, economics, psychology, and liberal arts and humanities that focus on mathematical literacy issues. Teacher preparation is also an important component of the project, and will capitalize on the involvement of the two Philadelphia public schools.

SIAM is providing expertise both in the development of the interdisciplinary modules and courses and in broad dissemination of materials through conferences, workshops, and products. Distribution of materials is planned through World Wide Web sites at the University of Pennsylvania and SIAM, as well as by commercial publication.

Mathematics and its Applications in Engineering and Science: Building the Links

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DUE-9552465
\$4,000,000

This project overcomes the traditional separation of courses into many different departments that often makes it difficult for students to grasp the intimate connections that exist between mathematics and its applications in engineering and science. Its three primary strategies are: 1) to stimulate greater cooperation among faculty in mathematics and other disciplines in the creation of instructional materials; 2) to encourage interactive teaching and learning strategies; and 3) to continue pioneering efforts in the application of contemporary technology for educational purposes. An important component of the project is the development of hypertext documents that link important mathematical topics with contemporary applications in fields of engineering and science. This involves collaboration among faculty at Rensselaer and a number of other institutions, including the University of Delaware, Siena College, Virginia Polytechnic Institute, Central State University, Hudson Valley Community College, and the University of Maryland. Through visiting faculty opportunities and workshops, additional institutions will become involved as the project develops. After careful testing and evaluation, the library of hypertext documents will be available on World Wide Web, on CDs, and in printed form. The project is expected to have broad impact, benefiting students at a variety of types of institutions. Two particularly important audiences for the project are students who preparing to be K-12 teachers and students seeking careers in advanced technological areas.

New Jersey Center for Advanced Technological Education

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(201)-548-6000

DUE-9553749
\$2,966,472
Engineering

The New Jersey Center for Advanced Technological Education is restructuring engineering technology education beginning in grade eleven, continuing through the associate degree, and articulating with baccalaureate programs. Project work covers interrelated curriculum and instructional materials development, faculty and teacher enhancement, and student outreach. Overall project management takes place at Middlesex Community College which serves as the lead institution in a consortium that includes Essex Community College (ECC), Mercer Community College (MCC), County College of Morris (CCM), Raritan Valley Community College (RVCC), the New Jersey Institute of Technology (NJIT), and Trenton State College (TSC). Each component of the Center's mission is being coordinated by a member institution: MCC is coordinating the curriculum development component; CMM is coordinating faculty development; ECC coordinates Student Outreach; TSC coordinates articulation of high school, associate

Supplements and Continuations

degree and baccalaureate degree programs and courses; NJIT concentrates on strengthening partnerships with business and industry; MCCC operates the NJCAT communications clearing house; and RVCC coordinates efforts relating to social, environmental and ethical issues. Mecomtronics (MEchanical/ COMputer/ teleCOMmunications/ electRONICS), the new program to be created under this plan, will respond to the widespread demand for a multifunctional engineering technician. An articulation agreement between the mecomtronics program and Trenton State's baccalaureate program in technology education is helping prepare secondary school teachers.

NSF COLLABORATIVES FOR EXCELLENCE IN TEACHER PREPARATION FULL COLLABORATIVES FOR FY 95

New York Collaborative for Excellence in Teacher Preparation

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DUE-9453606
\$4,999,996

Five colleges of the City University of New York (Brooklyn College, College of Staten Island, City College, Hunter College and Lehman College) together with New York University, are part of the New York Collaborative for Excellence in Teacher Preparation; formed to restructure the preparation of prospective teachers of K-12. The Collaborative goal is to increase the number of college graduates entering science and mathematics teaching at all academic levels, and better equip them for teaching these subject areas to New York's culturally, ethnically, economically and linguistically diverse population. New links are being created: on the college campus, between education and liberal arts faculties, and among the various science and mathematics faculties; in each borough, between colleges and school districts; in the university community, among various colleges; and city-wide, between all participants and local science-rich institutions and museums.

The Collaborative is engaged in six interrelated clusters of activities, including: 1) developing new approaches to teaching and assessing science and mathematics in college courses, so that prospective teachers themselves experience learning in ways envisioned by national reform efforts, and become familiar with exemplary curriculum resources; 2) establishing a new program for middle school teachers; 3) developing new training materials with special emphasis on design of curriculum units which reflect collaboration among faculty of varied disciplines and school teachers, and that utilize the urban context; 4) providing student support and career development, including follow-up of first year teachers and internships in settings such as college tutoring centers, school classrooms, and local science museums; 5) recruiting promising students into teaching; and 6) developing exemplary field sites for student teachers.

Los Angeles Collaborative for Teacher Excellence (LACTE)

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DUE-9453608
\$4,977,277

Ten institutions form the Los Angeles Collaborative for Teacher Excellence (LACTE): five universities/colleges (California State University, Dominguez Hills; California State University, Los Angeles; California State University, Fullerton; Loyola Marymount University; and Occidental College) paired with five allied community colleges (El Camino; East Los Angeles; Fullerton; Santa Monica; Glendale Community Colleges).

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The goals of the Collaborative are to: 1) increase the number of mathematics/science majors from underrepresented groups who are planning on teaching as a career; 2) refine the present course of study at each institution to reflect the necessary integration of mathematics, science and technology in the pre-service content preparation of undergraduate students; 3) develop an experiential component for future elementary mathematics/science specialists and secondary science and mathematics teachers; 4) establish a support network for the prospective teachers; and 5) promote professional development in education for mathematics and science faculty.

Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT)

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DUE-9453610
\$4,989,864

The Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT) is comprised of a large complex of low cost-base public higher education institutions which serve urban and rural areas with high ethnic populations. The collaborative consists of Arizona State University (science, engineering, and mathematics faculty), Maricopa Community College District (10 colleges in the Phoenix metropolitan area), and the Navajo Community College in the northeast corner of the state. ACEPT is collaborating with and has its goals aligned with the Phoenix Urban Systemic Initiative project and the Southern Rocky Mountain Alliance for Minority Participation.

Specific innovations are focused on the mathematics and science preparation of pre-service teachers. They include: 1) a new middle school endorsement with a secondary certification which will have science and mathematics options; 2) reform of elementary curricula - introductory physical science, chemistry, geology and mathematics; 3) reform of secondary curricula - biology and physics; 4) a new integrated curriculum, project oriented laboratory science course, Patterns in Nature, which will become required for elementary education majors; 5) incorporation of computers and other multimedia devices into the reformed curricula; 6) increased field experiences for beginning teachers and increased supervision; 7) establishment of a resource center for in-service teachers; 8) a significant increase in the number of teachers well-prepared in science and mathematics who are members of underrepresented groups; and 9) establishment of gender-neutral learning environments. The particular experiences planned for the novice teachers include: being paired with supervising teachers who will support appropriate pedagogical methods for teaching science and mathematics; and receiving rich and stimulating field experiences which will allow them to utilize the teaching methods learned from the ACEPT curriculum within their own classrooms.

The El Paso Partnership for Excellence in Teacher Preparation (PETE)

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DUE-9453612
\$4,641,407

The El Paso Partnership for Excellence in Teacher Preparation includes the University of Texas at El Paso (UTEP), the El Paso Community College, and the three major public school districts in El Paso County in a fundamental transformation of teacher preparation that is grounded in and contributes to systemic reform in K-12 education. The Partnership will sponsor activities contributing to four major goals: 1) to recruit more students into mathematics and science teacher preparation, particularly more minority students, and provide support and financial incentives for those planning to become teachers; 2) to revise and enhance curriculum at both the lower- and upper-division levels so that prospective teachers achieve high levels of both content knowledge and pedagogical skills; 3) to enhance the teaching skills of mathematics, science, and teacher education faculty so that they can both better impart content knowledge and model exemplary pedagogical behaviors; 4) to provide support for new mathematics and science teachers as they enter their profession; and 5) to establish and sustain a continuous conversation among key stakeholders (mathematics, science and education faculty, and public school teachers) on the improvement of mathematics and science teaching and learning.

**NSF COLLABORATIVES FOR EXCELLENCE IN TEACHER PREPARATION
FULL COLLABORATIVES FOR FY 94**

Rocky Mountain Teacher Education Collaborative (RMTEC)

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DUE-9354033
\$5,000,000

The University of Northern Colorado (UNC), Colorado State University (CSU) and Metropolitan State College of Denver (MSCD), are partners in the Rocky Mountain Teacher Education Collaborative (RMTEC). CSU, a research-oriented, land-grant university, has the largest secondary science teacher education program in the state; UNC, a university with a state-recognized mission for teacher education has one of the largest elementary and middle school teacher-preparation programs nationally; and MSCD, a four-year college in downtown Denver is committed to training teachers for urban schools and is the site of the largest middle and secondary mathematics education program in the state. The project includes: 1) on-going collaboration between teacher education institutions, community colleges, and 6-12 school partners for the reform of science and mathematics teacher preparation; 2) redesign and delivery of targeted science and mathematics courses for majors, with a central focus on research-based teaching and learning strategies such as inquiry, problem-solving, and constructivist approaches and utilizing appropriate interactive technologies; 3) enhancement of pre-service teachers' Pedagogical Content Knowledge by integrating content, pedagogy, and practice through the modeling of effective teaching; 4) development of a new CORE experience for student cohorts; 5) integrally involving teachers-in-residence in the planning and implementation of new science, mathematics, and methods courses; 6) development of faculty, teachers-in-residence, and student skills in addressing classroom diversity issues; and 7) recruitment and retention of women and other underrepresented groups in mathematics and science teacher preparation programs. The RMTEC institutions and project staff are working collaboratively with the participants in the Colorado Statewide Systemic Initiative.

Collaboratives for a New Model for K-12 Teacher Preparation Focused on Enhancing Math/Science Knowledge, New Methodologies and Technology

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DUE-9354034
\$3,900,000

The Temple University's Colleges of Arts & Sciences, Education, and Engineering & Architecture, the Community College of Philadelphia, and the School District of Philadelphia are developing a new model for the education of prospective K-12 teachers which integrates new teaching methodologies with mathematics and science core content courses. Since Temple University, in conjunction with the Community College of Philadelphia, is the major teacher preparation institution for the Philadelphia School District, this will have a systemic impact on the more than 200,000 students in the Philadelphia School District and serve as a national urban model. The Collaborative is revising selected basic college mathematics and science courses to reflect closely the pedagogy and content that the students will need as teachers. These revisions include: enhanced faculty/student interaction, appropriate instructional materials, inquiry-intensive methodologies as well as new technologies. Several courses are being developed and modified, including, for example, a team-taught cross-disciplinary science course and a cognitive psychology course. Prospective teachers are participating in practica early in their pre-service training at selected Professional Development schools. Practicum supervisors join pre-service teachers in seminars to reinforce content and pedagogy. The model includes expansion of Temple's five-year teacher education program in which students who major in Arts & Sciences and minor in education are certified after completing their 5th year. University and Community College faculty participate in intensive staff development and cross-class visitations with School District teachers

Teacher Education Addressing Mathematics and Science in Boston and Cambridge (TEAMS-BC)

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DUE-9354052
\$5,000,000

TEAMS-BC is a collaboration of Harvard University, Massachusetts Institute of Technology, Wheelock College, University of Massachusetts-Boston, Boston Public Schools, and Cambridge Public Schools. The collaborative is addressing the weaknesses in the preparation of elementary, middle, and secondary science and mathematics teachers by: 1) involving university and college science and mathematics faculty, along with education faculty and teachers, in the cooperative development of science and mathematics courses in teacher preparation programs; 2) emphasizing teaching for understanding and integrating content area and effective instructional practices; 3) creating ten Professional Development Schools - four elementary, two middle, and four high schools - which cooperate with the teacher preparation programs with special emphasis on mathematics and science, training mentor teachers in the inquiry, hands-on, case study based approach; and 4) establishing seminars at schools for teachers and university faculty to discuss problems in teaching effectively. Other emphases of the project are: the

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recruitment of minority students to teacher preparation programs; creation and promotion of area business-academic-school partnership programs in which both pre-service and in-service teachers participate in the application of mathematics and science in business and industry and use this knowledge to develop pedagogical materials for classroom use; and coordination with major mathematics and science initiatives in Boston and Cambridge.

NSF COLLABORATIVES FOR EXCELLENCE IN TEACHER PREPARATION FULL COLLABORATIVES FOR FY 1993

Maryland Collaborative Excellence in Teacher Preparation (MCTP)

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DUE-9255745
\$6,000,000

Institutions within the University of Maryland System, the State University System, Baltimore Community College, and Baltimore City, Baltimore County and Prince George's County school districts are designing, implementing, and evaluating an innovative interdisciplinary program to prepare teachers who can provide exemplary mathematics and science instruction in elementary and middle schools. Design and development of the project's course and field experience components are being guided by the following basic principles. 1) Teachers should learn science and mathematics through instruction that models the practices they are being expected to employ during their teaching careers; 2) Courses and field experiences should integrate science and mathematics so that teachers will know and can take advantage of the connections between individual disciplines; 3) Teacher training programs should include substantial field experiences that engage the prospective teachers in the genuine research activities of business, industrial or scientific institutions and the science and mathematics education activities conducted by science centers, zoos or museums; 4) Teachers should develop their ability to use modern technologies as standard tools for research and problem solving as well as for imaginative classroom instruction; 5) Field experiences should be provided in school settings that enroll children of below average and average ability, as well as those in gifted and talented programs; and 6) Teachers should receive sustained support during the critical first years of their induction to the teaching profession. Throughout the five-year development period, continual formative evaluation, research on the process of teacher education, and a variety of dissemination activities are being conducted to inform others of the outcomes of this emerging model of teacher preparation.

Louisiana Collaborative for Excellence in the Preparation of Teachers (LaCEPT)

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DUE-9255761
\$4,000,000

The Louisiana Collaborative for Excellence in the Preparation of Teachers (LaCEPT), and The Louisiana Collaborative, an integral part of the Louisiana Systemic Initiative Program (LaSIP), engages the efforts of key stakeholders to institutionalize statewide reform of teacher education in mathematics and science. The specific goals of LaCEPT are to: 1) establish a statewide consortium of key partners; 2) deepen understanding of reform issues; 3) develop a statewide strategic plan; 4) establish partnerships between school and college sectors; 5) reorder campus priorities and faculty rewards systems; 6) redesign pre-

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service courses in mathematics, science and methods; 7) revise instructional materials; 8) increase the number of certified teachers in science and mathematics, focusing on underrepresented groups; 9) expand the boundaries of research and practice; and 10) maintain national standards for teacher performance as students progress from pre-service to certification to extended service. The signature program of LaCEPT is sponsorship of campus-based renewal projects at Louisiana's public and private colleges and universities. Each campus develops a plan for long-term systemic renewal and fashions a distinctive proposal engaging mathematics, science and education faculty in the redesign of curriculum, instructional and assessment materials; mentorships and internships; partnerships with schools; research and technology centers; pre-college recruiting of potential teachers; and revision of certification standards.

Systemic Teacher Excellence Preparation: The STEP Project

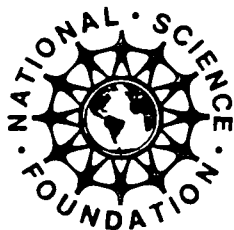
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DUE-9255792
\$6,000,000

The STEP project is designed to bring about large scale improvement in the preparation of science and mathematics teachers in Montana and to serve as a national model for rural areas with significant minority populations. STEP is developing new alliances that form a statewide, interactive network consisting of school systems, Tribal Community Colleges (TCC's), state Universities and Colleges, the State Office of Public Instruction, the Montana Council of Teachers of Mathematics, the Montana Science Teachers Association, the Montana University System and a number of related on-going NSF supported projects in the state: the Systemic Initiative for Montana Mathematics and Science (SIMMS), Six Through Eight Mathematics (STEM), and the Alliance of States Supporting Indians in Science and Technology (ASSIST). The project is providing the following: at least two years of early career support for mathematics and science teachers in a rural setting; model teacher preparation field sites in K-12 schools; increased numbers and better preparation of mathematics and science teachers from Native American Communities; a telecommunications network based model for fostering teacher preparation in rural states; strong faculty teams to redesign curricula and courses; strong institutional support for participating faculty and teachers; dissemination of new ideas in preparing teachers; an increase in the number of women and minority teachers in mathematics and science; and use of field sites as "living laboratories" for research on effective mathematics and science teaching, pre-service teacher supervision and the training of university science and mathematics educators in rural settings.

LIST OF AWARDS BY STATE

	<i>Award No.</i>	<i>page</i>		<i>Award No.</i>	<i>page</i>		<i>Award No.</i>	<i>page</i>
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				9555181	16			
Arizona	9602373	5		9555194	17	Tennessee	9555059	13
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	9453610	48		9554736	35			
				9354052	51	Texas	9650654	26
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	9554685	34	Minnesota	9555091	14		9650467	25
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Connecticut	9555134	15	Nebraska	9555404	7			
Delaware	9553787	3	New Hampshire	9552462	44			
District of Columbia	9554939	11	New Jersey	9553749	45			
	9555205	17	New York	9555401	6			
	9622600	36		9555152	15			
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